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THE PHILIPPINE
JOURNAL OF FISHERIES

VOL. 6 JULY–DECEMBER, 1958 NO. 2

REPORT TO THE GOVERNMENT OF THE PHILIPPINES ON MARINE FISHERY RESOURCES [1]

THREE TEXT FIGURES

INTRODUCTION

NARRATIVE AND ACKNOWLEDGMENTS

In 1955 Dr. D. V. Villadolid, then Director of Fisheries of the Republic of the Philippines, discussed with the Fisheries Division of FAO the need for more intensive and more practically oriented research on the fishery resources of the Philippines. Dr. Villadolid referred to the current status of fishery industries in his country, to problems confronting the extension of fishing operations to under-exploited or neglected resources and the improvement of efficiency of these operations and to the need for more systematic research that would result in more precise account of the accessible resources (location, magnitude and behaviour and changes in these characteristics) and in systems of prediction of these changes. These discussions led to a proposal for a project under Technical Assistance in which, using the tuna resources as example, training would be given to Philippine workers in the identification of problems in the planning of research programmes for elucidation of these matters, and in the techniques required for such research including, of course, the techniques of treatment of data and interpretation of results. Agreement was subsequently reached between the Government and the Organization for the conduct of this project and Dr. K. F. W. Tiews of Germany was selected to be the expert for it. Dr. Tiews entered on duty 1 October 1956 and after a briefing period at FAO Headquarters in Rome, arrived

[1] Based on the work of Dr. K. F. W. Tiews, FAO Expert in Fisheries Biology.

in the Philippines on 16 October of that year, he remained in the Philippines until 16 October 1958, at which time he proceeded to Bangkok, Thailand to participate, as one of the instructors, in the International Training Centre on the Methodology and Techniques of Research on Mackerel (*Rastrelliger*) he was able to make much use at this centre of the materials gathered in the Philippines during his assignment.

The terms of reference given to Dr. Tiews for his assignment were: "to assist the Government in the planning of a programme of research in marine fishery biology and to give training to Philippine workers who are to carry out this research; to make use of the Government's programme of research on the tunas as a means of demonstrating techniques to be employed and to assist in planning and organizing research work on tunas."

He was further instructed that in development of research work on tunas he should cooperate closely with Mr. Tatsuzo Suzuki, FAO Master-fisherman (Fishery Engineer), who had been assigned in the Philippines to demonstrate tuna longline fishing and other advanced fishing methods.

Since the Government's programme of research on the tunas could not be fully implemented during the expert's assignment, because of the lack of facilities, he demonstrated the techniques to employ in marine fishery biological research by programmes on other resources.

In the following pages an account is given of the activities in which Dr. Tiews and his Philippine associates (counterparts) engaged themselves during his assignment, showing the diverse subjects on which they directed their attention, the observations made by Dr. Tiews on the matters referred to in his terms of reference and described in detail in his technical instructions, and the conclusions he has come to concerning the main objectives for which this project was established.

Dr. Tiews takes the opportunity here of recording the effective role played by the Director of the Bureau of Fisheries, Mr. H. Montalban, and the Chief of the Fisheries Research Division, Mr. C. Martin, in supporting and implementing the plans for development of the research services; their interest in the work and their efforts in solving administrative and other problems have been unfailing. He also records the enthusiasm and untiring efforts of colleagues and friends in the Bureau of Fisheries, the Fisheries College of the University of the Philippines

and the National Museum, especially those of Mr. I. A. Ronquillo, Mr. S. B. Rasalan and Mrs. P. C. Borja. Members of the Inter-island Deep-sea Fishing Association, especially Mr. I. Lachenal, President of the Association, cooperated in the work.

Valuable help was received from the National Research Council, the National Science Development Board, the National Economic Council, FAO Headquarters and the Technical Assistance Board in Manila. Mr. Eric Ward, United Nations Technical Assistance Board Resident Representative in the Philippines, and Mr. Hart Schaaf, who succeeded him in October 1957, displayed great interest in this work and gave invaluable help.

The assistance to be received from the United Kingdom Government under the Colombo Plan and the cooperation obtained from Her Majesty's Embassy in Manila must be acknowledged with great gratitude.

PRELIMINARY REVIEW OF THE SITUATION AND OF THE WORK ACCOMPLISHED

The vast assemblage of islands that constitute the Philippine Archipelago lies completely within the tropics and, besides, lies close to the center (the Indonesian Archipelago) from which is dispersed what is known as the Indo-Pacific (or Indo-Australian) fauna. These geographic and zoogeographic facts have very considerable implications for the fisheries of this country, and for fisheries research. The marine life of the tropics presents many problems whose resistance to solution has been maintained by their very intricacy, abetted by the relative neglect to which they have been subjected. The great number of species in the tropics is a taxonomic maze whose methodological significance for fisheries biology is by no means clear; although the fisheries biologist might find it permissible to disregard some of the heterogeneity of these stocks, as for example, by treating a number of closely related species as a single population, the administrator might find this invalid for management of the fisheries. Beyond these questions of identity there are problems in the dynamics of fish populations of the tropics, relating to matters such as growth rate and reproduction, which have confounded fishery biologists in the past, but whose resolution is indispensable for the analysis of these systems and the development of prediction techniques. Moreover, there are socio-economic aspects of these fisheries which give them an especial character such that *a priori* assumptions that

methods developed in temperate countries could be applied here might often prove invalid; at least, these socio-economic aspects (and certain administrative aspects) present special difficulties, as for example in the collection of catch and effort statistics.

These, and other facts established by Dr. Tiews during his assignment have important bearing on interpretation of the situation prevailing in the Philippines when Dr. Tiews began his assignment—interpretation, that is, of the condition of the fisheries and of the status of the programme of research and administration; they also have a bearing on understanding the history of this situation and on planning for the future.

Fish is an important commodity in the Philippines; fishing is an important occupation. The annual Philippine catch is estimated to be approximately 400 thousand tons; in 1957, additional 56 thousand tons fish products were imported to cover the local needs. But the real requirement of fish, based on the per capita normal consumption of 25.55 kg. as established by the National Research Council of the Philippines in 1949 has been calculated to be about 600 thousand tons. However, this calculation may be of little significance; first because of inaccuracy in taking catch data, especially with regard to subsistence fishing, and second because of the diverse forms in which the total catch is disposed. Although nearly all the catch is used for human consumption, and efficient use is made of this, nevertheless, the fish supply is inadequate and would progressively become more so if in the face of the rate of population increase the rate of production of fish did not accelerate.

Available statistics shows 15,400 men to be engaged in the commercial fishing operations, using 1,100 boats, and that some others are engaged in the 'municipal' fisheries; the amount of part-time occupation that fishing provides has not been estimated. These figures, although impressive, do not give a real index of the significance of this industry to Philippine economy: much more has to be understood of the ubiquity not only of the fishing operations but also of the processing and marketing operations and those of ancillary industries, and of the universality of fish as dietary element.

The importance seen by the Government of the Philippines in this industry is indicated by the status of the Bureau of Fisheries, and by the magnitude of the expenditures on this office. The activities of this office are complemented by those of the

Municipal Administrations: it is perhaps an indication of the situation that local administrations have wished to retain a responsibility for this industry; it is certainly understandable, considering the degree to which this industry permeates the local economies. The two sets of administration concur in recognizing the desirability of developing the industry, even if the means available to them with which to promote such development might differ. The Municipal authorities are responsible for vessels of size less than 3 tons and thus chiefly with the on-shore, littoral fisheries; the Government has responsibility for the larger vessels and has research facilities at its disposal. This allocation of responsibility creates certain difficulties, most notably in the matter of collection of statistics, but also with regard to identifying the problems confronting the industry and to formulating and implementing a developmental programme common to all sections of the industry. In fact, the putative conflict of interest between trawlers and on-shore operators is an example of the problems requiring solution, and an indication of the need for a common policy and plan for this industry.

Basically there is a need to develop the industry to be able to take a larger catch; the questions are: can this be done? from which of the resources? where? by what means? Next there are questions concerning the efficiency of current fishing operations and of any new operations that might be developed; such questions raise issues such as whether the operational costs are of a kind and a magnitude appropriate to the economy.

It is natural that appeal should be made to research to furnish answers to these questions and the Government has not failed to recognize the possible value of research in this field. A brief review of fisheries research in the Philippines is given in Section 2 of this report. The Philippine Journal of Fisheries is witness of the attention that has been devoted to marine life and fisheries, however, at the same time this journal shows that for the most part this attention has been concerned with matters of taxonomy, general biology, and technology, and generally the papers have been descriptive. At the same time it must be said that in these respects fisheries research in the Philippines had much in common with fisheries research elsewhere in the world, and that the characteristics were those of fisheries science of the time, immature as it then was, rather than being characteristics particularly Philippine.

On his arrival in the Philippines, therefore, Dr. Tiews found that his task was, as described in his technical instructions, one of establishing a modern programme of fisheries research. He had to assist in identification of problems to whose solution research in fisheries biology could make some contribution. He had then to assist in selecting the techniques and in designing observational and sampling programmes that would gather the required information. This report describes his accomplishment along these lines. At this point it is likely to be useful if a simple statement is made on the role which Technical Assistance can play in a situation such as this.

The basic task given to Dr. Tiews was to train Philippine workers in the prosecution of applied research on problems of Philippine fisheries. The whole of his activities was directed to this end. However, in order to make that training realistic and truly effective he had to work for the setting up of a real programme; problems had to be selected that were not merely exercises but part of the Philippine research programme, and activities had to be directed as a full scale operation, and not a full-dress rehearsal. Problems were studied with considerable energy and results were obtained; but, so far as the project was concerned, these results (although they may prove immediately useful) were of more importance in providing a basis for discharge of Dr. Tiews' second responsibility, namely to assist in formulating a long-range programme of research. The report that follows shows the degree to which Dr. Tiews succeeded in achieving these objectives, namely, of training, and establishing the means for research; identifying problems; formulating a research programme. Sections 3, 4 and 5 deal respectively with these aspects of his assignment.

HISTORY OF FISHERIES RESEARCH IN THE PHILIPPINES

The first marine research in the Philippines dates back 160 years, and since then the main efforts of researchers of many nations have been directed to identifying the very rich fauna of the archipelago. Albert W. Herre, in his Check List of Philippine Fishes (*Research Report* No. 20, U. S. Fish and Wildlife Service, 1953) records no less than 2,277 fish species grouped in 205 families and 716 genera.

Oceanographic research by deep-sea expeditions in the Philippine Archipelago has contributed greatly to knowledge of the area. Most noteworthy are the British "H.M.S. Erebus and

Terror" (1839–43), the Spanish Frigate "Navarra" (1857–58), the British "H.M.S. Challenger" (1872–76), the U.S. Fisheries steamer "'Albatross' (1907–09), the German survey vessel "Planet" (1907–12), the German cruiser "Emden" (1927), the Danish steamer "'R.S.S. Dana II" (1929), the Dutch steamer vessel "H.M.S. Willebrord Snellius" (1930), the American warship "Cape Johnson" (1945), and the Danish Navy Corvette "Galathea" (1951). However, the first applied oceanographic investigations of value for commercial fisheries were carried out from 1947 to 1950 by the Philippine Fishery Programme of the United States Fish and Wildlife Service. During this period an intensive exploration of Philippine and adjacent seas was made by the "U.S.M/V. Spencer F. Baird". More than 1,100 oceanographic stations were established over an area of more than 800,000 sq. mi. The data collected are still being compiled and analysed in the United States.

After the termination of the Philippine Fishery Programme in 1950, the Bureau of Fisheries continued oceanographic research in the principal fishing areas, such as Manila Bay and Lingayen Gulf. The operation had to be discontinued in 1955 for a general overhaul of the research vessel "M/V David Starr Jordan". Because of lack of funds, this delay continued until 1957.

Although fisheries research in the Philippines, especially from 1947 54, indicates a modern approach to fishery problems through systematic scientific studies, little attention has been paid to real marine fishery biological research. Special research has only occasionally been undertaken, to describe the several larval forms of marine fish, to determine the racial status, spawning and feeding habits of tuna, the taxonomy and feeding habits of *Rastrelliger* sp. The lack of a well-balanced fisheries research programme minimized the usefulness of the oceanographic surveys in coastal areas intended to contribute to the explanation of fishery phenomena.

The activities of the Bureau of Fisheries in marine fishery biological research are barely significant compared with its other activities. Greater efforts have been made, for instance, in the fields of fresh and brackish water fisheries biology, aquiculture, fish processing and especially in fisheries technology.

The lack of knowledge of the biology and life history of the important marine food fishes, of their behaviour, distribution and migration, etc., became more obvious in recent years

when controversies arose among different groups of fishermen regarding depletion of the resources and extention of the fisheries.

It must be stressed here that the necessity of intensive marine fishery biological research has been recognized by the Department of Agriculture and Natural Resources, and by the Director of Fisheries and his technical staff.

INSTITUTIONAL STRUCTURE, STAFF AND FACILITIES FOR RESEARCH

ORGANIZATION

Research in marine fishery biology is carried out for the Bureau of Fisheries by the Division of Fisheries Research headed by Mr. Clare Martin. This is one of the five divisions of the Bureau. The others are: (1) Administrative Services, (2) Marine Fisheries, (3) Inland Fisheries, (4) Licenses and Regulations.

The Division of Fisheries Research is subdivided into the following sections: (1) Hydrology and Fisheries Biology, (2) Technological Research, (3) Fisheries Economics and Statistics, of which the Hydrology and Fisheries Biology Section, headed by Mr. L.A. Ronquillo is responsible for research on marine resources.

The marine biological research that is occasionally carried out by the Department of Zoology and Botany of the University of the Philippines (U.P.) is mainly taxonomic relating to all kinds of marine life. It is possible that the University will increase its efforts in marine research, more closely related to fisheries since the transfer to it in January 1957, of the Philippine Institute of Fisheries Technology, renamed "Fisheries College" of the U.P., and its technical staff, formerly under the Bureau of Fisheries.

RESEARCH SHIPS

During 1956-58 the Bureau of Fisheries had one research vessel, the "M/V *Isaac Stoy Jordan*", in running condition. The boat was acquired in May 1950 as part of the equipment and supplies turned over to the Philippine Government by the Government of the U.S.A. at the termination of the Philippine Fishery Programme of the United States Fish and Wildlife Service. The boat is 16.2 m. overall, 14.6 m. at the water line, 4.9 m. in beam and 2.9 m. in draft. The 56-ton vessel is driven by a 135 h.p. Murphy diesel engine, giving a cruising speed of 6 to 7 knots. The boat is equipped with different

kinds of echo recorders and fish finders and with a hydrographic winch which can pay out the 5/32-inch hydrographic wire at the rate of 2 inch/sec. and haul in at about 1 to 6 m./sec.

Unfortunately, the more than 12 years old wire has become rusted and must be replaced to avoid the loss of the valuable hydrographic sampling equipment. Several hundred meters of the wire, which originally measured some 2,000 m., had to be cut off because of its bad condition. Nevertheless the wire broke twice during the intended oceanographical cruises, causing the loss of two Petersen bottom samplers and one Hensen egg net.

Although the boat is stable, seaworthy and highly maneuverable, it is too small to carry out systematic research in the high seas. It is suitable only for research in bays and other coastal waters.

The boat has been out of active since September 1958 and must be dry docked urgently for overhaul of its engine and hull. Since the repair of the boat will cost at least ₱25,000.00 and since its 15-year-old engine is the only example of this type in the country (for which no spare parts are readily available) and is a permanent source of trouble, it should be thoroughly studied whether the sale of the boat would not be more advantageous than its repair. The proceeds would, with what would have to be spent on repairs, easily cover the cost of construction of two large-sized banca-type research vessels urgently needed for proper continuation of the programme of investigations on demersal and pelagic fish stocks already initiated. Compared with the "M/V *David Starr Jordan*" a large-sized banca-type research vessel would have the enormous advantages of being cheaper in its purchase and maintenance costs, more seaworthy, and safer for the crew members, consequently giving the added advantage of a better operation radius.

A modern 4-Boat is available not only without engine. The boat is 10.8 m. overall and 2.7 m. beam. It will be equipped with 2 [illegible] h.p. Diesel. This boat also is suitable for coastal fisheries research.

Since these boats are under the jurisdiction of the Division of Marine Fisheries and are not always available to the Division of Fisheries Research, which has continuous sampling programmes, a third boat for the sole use of the latter was purchased in September 1957, at the recommendation of the

writer, with the Project Development Funds of the Technical Assistance Programme 1957–58. It cost only ₱1,500.00. The boat is a stable banca 11 m. overall and 1 m. beam. The sides of the banca were raised by 50 cm. and the width increased by 70 cm. The boat is built as a *basnigan* with two outriggers and is equipped with a 25 h.p. Continental gasoline engine. It represents the ideal seaworthy type of small boat for coastal research. It is now being used in the baby trawl operation of the newly initiated research programme in marine fishery biology and rendered valuable service in 119 field trips from September 1957 to September 1958, each lasting one day.

Two more boats, each of 100 tons, built and urgently needed for offshore research, are expected from Japan through the War Reparations Commission within the near future. Their measurements are not yet known to the expert. However, only one of these boats will be under the jurisdiction of the Bureau of Fisheries, while the other will be given to the Fisheries College of the University of the Philippines to be mainly used as training ship for students.

Because of the unavailability of the "M/V *David Starr Jordan*" the usual two-days' plankton cruise in Manila Bay was accomplished for the first time in September 1958, through the kind cooperation of the Philippine Navy which assigned a patrol boat for this purpose. The expert would like to express his sincere appreciation for the excellent cooperation extended by the respective authorities of the Philippine Navy and his hope that the Philippine Navy may in the future continue its cooperation in extending any assistance needed to avoid interruption of the researches.

Finally, on the recommendation of the expert, the Division of Fisheries Research intends in due course to request funds for the construction of a large banca type "basnigan" research vessel, of the type being used in the commercial fishery, to be operated from Mercedes, Camarines Norte, on the Pacific side of southern Luzon in order to investigate one of the richest fishing grounds of the Philippines which is yet undeveloped and unsurveyed.

For future coordination of research to be carried out with these boats by the Division of Fisheries Research, the Division of Marine Fisheries and the Fisheries College of the U.P. and the Navy in cooperation with the Bureau of Fisheries, it will be a matter of urgent necessity to establish a special

"council for the coordination of marine research", in which each research unit is represented, in order carefully to plan the operation of the boats.

FIG. 1. Station Map of Manila Bay

RESEARCH LABORATORIES AND THEIR EQUIPMENT

The previous research laboratories of the Bureau of Fisheries were transferred in 1952 from the main office of the Bureau of Fisheries and from the Philippine Institute of Fisheries Technology *, to the Dagatdagatan Salt-water Fishery Experi-

* Referred to later as PIFT

mental Station. This station was established in 1936 for fish-pond experiments. It is situated on an island in a lagoon in the Malabon river, in the suburbs of Manila, some 12 km. from the Central Office of the Bureau. It consists of a pond area of 11 hectares and of 6 wooden one-story buildings, one of which was constructed during 1956–58. Four buildings and ⅔ of the space of the largest one are being used by the Section of Hydrology and Fisheries Biology. The remaining space is used by the Section of Technological Research for its pilot canning plant, one chemical laboratory, one bacteriological laboratory and several small offices and store rooms.

In the Section of Hydrology and Fisheries Biology one small hydrographic laboratory and a biological laboratory were available on the arrival of the writer. All other rooms were used as store rooms and offices and as lecture hall, or were still under construction.

In accordance with the research initiated there are today:

one pelagic fish laboratory;
one demersal fish laboratory;
one taxonomic laboratory;
one physiological laboratory with separate air-conditioned aquarium room;
one hydrographic laboratory;
one planktonological laboratory;
one biostatistical laboratory;
one fish culture laboratory;
one photographic laboratory;
one station library;
two offices;
three store rooms.

A ground plan of the station building is attached (see Appendix 7.0). At present a building is under construction to house the prospective secretariat and the director's office. Also an air-conditioned and fire-proof store room for the valuable and sensitive equipment is being constructed. It is also intended to erect a new oceanographic building to provide sufficient laboratory working space for the investigations in hydrography, and on plankton, benthos and primary production. The two rooms now being used for this purpose will be used as a biostatistical laboratory. It will also be necessary in due course to construct a separate building for brackish water research, especially a suitable fish culture laboratory. Favourable consideration should be given in future expansion to construction of a lecture hall, more suitable storage for oceanographic sampling equipment, a workshop, and a dormitory for local staff and guest researchers.

All laboratories have fresh water supply and electric current, but except for the aquarium room of the physiological laboratory,

are without air conditioning, and are rather hot during the summer.

The isolated position of the station may give a quiet research atmosphere, but has the disadvantage of inaccessibility, not only for the research staff, but also for the transport of material. A small pier for the transport boats and a permanent footbridge to replace the bamboo bridge which spans the Malabon river would improve matters.

A smaller limnological laboratory exists in the Tanay Limnological Station, Tanay, Rizal, but is of limited value because of insufficient water supply during the dry season when most of the fresh water fish ponds dry up.

There was a general lack of essential equipment in the biological and oceanographic laboratories of the Dagatdagatan Experimental Station. The equipment in use was acquired at the termination of the U.S. Philippine Fishery Programme in 1950. Since then no new equipment has been purchased. The hydrographic laboratory was well-equipped with Nansen bottles and reversible thermometers. Ten Nansen bottles and 12 reversible protected thermometers were still in good working condition. The stock of glassware (pipettes, burettes, chlorinity bottles, oxygen bottles, etc.) and of chemicals was insufficient.

The equipment of the biological laboratory consisted only of two binocular microscopes, one compound microscope, two triple beam balances, one torsion balance, dissecting instruments and dissecting pans for two workers and one calculating machine. It was possible, through the joint efforts of the Bureau of Fisheries, the National Research Council, the National Science Board, the National Economic Council, the Resident Representative of UNTAB, the FAO Headquarters and the Colombo Plan through the United Kingdom to acquire the considerable quantity of equipment listed in Appendix 7.1.

Large quantities of tin cans, preserving jars, chemicals, preserving fluids and other supplies were purchased. A complete set of sampling equipment for the measurement of primary production by means of C-14 techniques was acquired at cost from the University of Hawaii, through the help of Dr. Maxwell Doty.

Although there has been much important progress in assembling research facilities during the last two years, the equipment is still inadequate, lacking all kinds of sampling gears such as bottom egg nets, dredges, standard plankton

nets, etc. Since none of these items of equipment were available locally the expert spent much of his time assisting the Bureau of Fisheries to prepare a request for assistance from the Colombo Plan through the United Kingdom Government. This request upon which so much research activity depends was recently approved so that if and when the equipment arrives the laboratories will soon be among the best equipped laboratories of this kind in this part of the world.

However, funds available to the station must be sufficient to permit maintenance and replacement of supplies and equipment so that there should be no interruption of research effort. There is a high "loss risk" in the use at sea of equipment such as sampling gear, and nets especially have a relatively short span of life—about one or two years. Although the oceanographic sampling equipment was handled very carefully the loss of two bottom samplers and one of the Hensen egg nets could not be prevented, and also one of the ring trawls and the two small plankton nets were more or less destroyed during recent cruises in Manila Bay.

RESEARCH STAFF

When the expert arrived in the Philippines, the Director of Fisheries promptly assigned counterpart assistants to work with him. These were the 14 members of the Section of Hydrology and Fisheries Biology, to which 11 workers of other Sections were added. There was also an opportunity during 1956–58 to select trainees from a large staff of some 60 emergency employees of the Bureau of Fisheries who worked temporarily under the Project from one to several months. These employees were incidentally laid off because of insufficient funds and only those assistants who volunteered to work without pay could be retained. The readiness to work without pay characterizes the enthusiasm and idealism of the young research team finally selected. Although the trainees were mostly graduates of the PIFT, they lacked the training and background needed for independent research work. The expert therefore requested the help of the Department of Zoology of the University of the Philippines in arousing interest among young BS graduates in Zoology in the promising field of marine research; as a result seven graduates were carefully screened out of a group of 12 and joined his training team and worked on their thesis for the MS degree under his supervision.

Another group of BS graduates from UST and other universities joined the team.

To date, 59 of these assistants have undergone training. Six of them left Dagatdagatan laboratories in the meanwhile, three having been reassigned to positions in other divisions of the Bureau of Fisheries; one was sent abroad for training; two left in order to accept a better position in another Bureau. Twenty one workers of the available research staff are permanent employees of the Bureau of Fisheries, 24 are being paid from the Project Development Funds of the UNTAB and 8 have been retained as emergency employees of the Bureau of Fisheries. Thirty are female and 23 are male.

A total of 908 student-months of training was given, some trainees being under instruction for two years, some for only a few months. The names of the employees having participated in the training programme are given in Appendix 7.3.

The main problem which faced the expert was the lack of adequate funds. Although officials of the Bureau of Fisheries did their utmost to secure these, nearly every month the emergency employees had to be laid off, sometimes for several weeks. In July 1957, after the new fiscal year 1957–58 had started, the situation became still worse because funds provided in the new budget of the Bureau were inadequate and available funds were still smaller. The only possibility for continuing the then well-established research programme was to approach the Resident Representative of the UNTAB, Mr. Eric Ward, for money which was to have gone into a project in marine fishery biology of the Bureau of Fisheries. This project, which had been rejected, had called for $10,966.00 of FY 1957 technical cooperation funds (ICA) and ₱88,600.00 of counterpart funds (NEC). On the recommendation of the writer and assisted by him, the Director of Fisheries therefore requested the application of ₱76,700.00 from the Project Development Funds of the Technical Assistance Programme 1957–58 in connection with the expert's project. The request was approved. However, it was reduced to an amount of ₱50,000.00 from which not only the salaries of the trainees who were formerly emergency employees of the Bureau of Fisheries were paid after July 1957, but also essential equipment and supplies were purchased during FY 1957–58. Besides this main source of funds, ₱15,500.00 and ₱3,000.00 were secured from the National Science Board and the National Research Council.

Although the allocation of funds from the Project Development Funds of UNTAB has been made on the condition that corresponding amounts would be included in the budget of the Bureau of Fisheries for the fiscal year 1958–59, as was also very strongly recommended by the expert in his "Interim Report to the Government", a corresponding request of the Bureau of Fisheries was rejected by the Appropriations Committee of Congress because of the strictly followed budget limitations exercised in connection with the austerity programme of the Government. To ensure successful continuation of the research project, which UNTAB and the National Economic Council considered to be of great importance for the economic development of the country, both agreed to the allocation of another ₱78,000.00 for fiscal year 1958–59 as requested by the Director of Fisheries and recommended by the expert. However, it is understood that a decision with respect to the final financing of the research project must be reached before the end of this period.

It cannot be stressed enough that the continuation in service of the very promising researchers who have been training under the expert is essential for proper development of the marine fisheries biological research so much needed to develop fully the marine resources of the Philippines. The budget for the next year should provide sufficient posts which should be reserved for suitable male graduates in Zoology of the U.P. The need for such an arrangement becomes obvious from the following tabulation of the present staff:

	Male	*Female*	*Total*
Laboratory Aides	1	7	8
Asst. Fishery Tech.	11	14	25
Fishery Technicians	3		3
Fishery Research Asst.	5	8	13
Fishery Research Biologist or Oceanographer	3	1	4
	23	30	53

Assignment to these groups was made according to the educational background of each staff member; only those workers who are graduates in Zoology or chemistry were classified as Fisheries Research Assistant and Fishery Research Biologist or Oceanographer; all others, having graduated in the PIFT and in

other courses, form the necessary team of Assistant Fishery Technicians and Fishery Technicians, the technical staff. The category "laboratory aides" serves to accommodate the newcomers who are placed on test for their ability and aptitude for research. A list of personnel as classified in the project is given in Appendix 7.4.

The writer spent appreciable time during the two years in training workers in the research detailed below. Emphasis was placed on practical training. Since marine fishery biological research relies heavily on suitable sea-going staff, most of whom must be male, as much training as possible was given on commercial fishing boats or on research vessels. Not all of these assistants proved suitable for sea-going work and some still have to become accustomed to hard conditions. Each male assistant spent at least 65 days at sea participating in the 230 field trips, which covered 410 days; some of them spent more than 150 days at sea.

In addition to the practical training, a weekly seminar was held, starting in January 1957. Reports on scientific important research in the world were distributed to trainees for later discussion.

The aim was not only to train them in exact reading of literature in oral reports and in discussion, but also to impart a broader knowledge of literature. Short lectures were included in connection with the reports. In all, 78 seminars took place during which 112 reports were made and discussed. This kind of training seemed to be highly profitable to the young research team, and the expert hopes that it will remain a permanent institution.

From the very beginning the trainees were assigned to practical research work. Within each team the trainees were requested to interchange their responsibilities. Newcomers can now be initiated in their tasks by their experienced fellow team workers.

The overall programming and administration was the responsibility of Mr. Martin, Mr. Ronquillo, assisted by Mrs. Borja, Mr. Llorca and Mr. Datingaling. A list of trainees and their assignments is given in Appendix 7.5.

Although the progress made by the trainees is most encouraging and the expert has no doubt that most of the researches can be independently continued, one should be aware

that the research team still lacks adequately trained leaders. Arrangements were made to obtain further training experience abroad. An officer will visit several European fishery research institutions as FAO Fellow; to study their programmes, installations and organizations. ICA awarded to Mr. I.A. Ronquillo a six months' scholarship to the U.S.A. to visit several fishery research institutions and to study their organization, and the methods used in the treatment of hugh materials of statistical data. Mr. E. Bernabe, Mr. J. Ordoñez and Miss L. Mañalac are supposed to study in the United Kingdom under the Colombo Plan. Mr. Bernabe shall receive advanced training in Planktonology, Mr. Ordoñez, in Fisheries Biology and applied Oceanography and Miss Mañalac in Fisheries Taxonomy. Mr. A. Mines has been recommended to the Government of the Federal Republic of Germany for advanced studies in fisheries biology and applied oceanography in its Fisheries Research Board in Hamburg. Miss E. Tan has applied for a scholarship in Germany to take courses in Fisheries science at the "Christian Albrechts University" in Kiel. Miss T. Mangosing left in May 1958 for Tokyo Fisheries University. A five-years' scholarship on Fisheries has been awarded to her by the Japanese Government.

Mr. B. Y. Datingaling, Miss E. Tan and Mr. R. de la Paz participated in the International Training Center on the Methodology and Techniques of Research on Mackerel (*Rastrelliger*) in Bangkok from 20 October to 28 November, 1958.

The writer would like to stress that, in his opinion, no trainees aside from those mentioned above should be sent abroad within the next two years because if they were, the continuity of the whole research programme would be disrupted. One should also not overestimate the value of training gained in other countries which normally deal with totally different research projects and should not forget that the real researcher develops most quickly in active work in his country under existing conditions.

LIBRARY FACILITIES

A good scientific library is essential to keep the researcher up to date with the methods being applied in his field and with results being obtained in other countries. Lack of library facilities tends to isolate workers and can easily lead to failure and to a waste of effort and money.

When the PIFT was transferred to University of the Philippines in January 1957, the greater part of the library of the Bureau of Fisheries went with it. This library, however, contained very few of the important periodicals in the field of fishery biology.

Today, by the joint efforts of the Bureau of Fisheries and the expert, the library of the Bureau of Fisheries, which is kept as station library at Dagatdagatan laboratories, receives 150 new periodicals on fishery biology and technology from 30 countries in exchange for "The Philippine Journal of Fisheries" and the "Bulletin of the Fisheries Society of the Philippines". The replies to a further 100 exchange proposals are still awaited.

RESEARCH PROGRAMME

IDENTIFICATION OF PROBLEMS AND INITIAL PLAN OF WORK

As stated in the Introduction, this project was set up because of Philippine belief that biological research would make possible an expansion and reorganization of the Philippine fishing industry, or, at least contribute to such reorganization. As initially formulated, the questions were: can fishing, and hence the catch, be increased? If so, on what resources, by what methods, to what extent and with what risks? And, further, can the efficiency of current operations be increased? Could the effects of fluctuations be reduced? And the threat of over-fishing eliminated? Could improvements of economic kind be brought to the industry? These of course are the general questions confronting any industry and leave the biologist still to decide which sets of data procurable by his techniques would give part of the answer to these questions—part, because most, if not all of these questions involve technological and economic considerations.

In their initial form the questions leave open the possibility that the need might be for exploratory fishing or prospecting, for general biological studies or for stock assessments. However, three considerations gave the expert appropriate grounds for selection of a programme. Firstly, the nature of the facilities available. These were such that the research on tunas, which had been proposed, could not be undertaken and, in fact, considering all aspects of the situation it became obvious that the bulk of the work should be done in and near Manila Bay, where research accommodation, library and other facilities,

access to markets, fishing fleets, etc., were best. Secondly, the relative importance of fisheries, those of Manila Bay being the largest and most dense geographic unit. Thirdly, the existence of a controversy regarding the best means of exploiting Manila Bay resources led to identification of particular required sets of data.

The expert had then to propose the particular studies which could be undertaken with prospect of useful results, both for the fisheries generally and for training purposes.

His conclusion was that the best course would be to initiate a programme of studies of the biology of important species. This would furnish information basic to and required for other purposes (e.g. stock assessment) and would offer opportunities for employment of the widest range of biological techniques. Such a programme should be accompanied by complementary programmes in biological and physical-chemical oceanography since many of the results from the study of biology of economic species would be interpretable only in the light of data on the environment of those species.

Having reached this conclusion the expert set about the establishment of this programme. He began the training of staff and their assignment to particular studies. The more important pelagic and demersal species were chosen for study and work was begun on these. As the numbers of trainees increased it was possible to extend the range of studies.

Basically the objective of the biological studies was to obtain data on the identity of the important fishes, the location (in space and time) of their stocks, the main features of their life-history (reproduction, growth, etc.) and the characteristics of their populations. The full schedule of the features required for comprehensive description of a species is given in Appendix 7.8.; this is the outline employed by the Biology Branch of FAO's Fisheries Division in the preparation of synopsis of data on species.

RESEARCH ON FISH STOCKS

Biological investigations were initiated on the most important fish species of the so-called "commercial fishery" which is carried out with boats over three tons gross. These boats and their catches are under the supervision of the Insular Government. The smaller boats are supervised by the Municipal Governments. The "Fisheries Statistics of the Philippines 1956"

prepared by the Bureau of Fisheries gives the following yields obtained in 1956:

	Kilograms	Pesos
Commercial fishing vessels	106,659,273	70,815,216
Municipal fisheries and sustenance fishing	248,509,138	228,628,407
Fishponds	38,479,765	49,638,896
	393,648,176	349,082,519

Since the Municipal Government does not record the catch of each kind of fish separately the importance of each type of fish was taken to be represented by the proportion which each net yielded to catches of commercial fishing vessels. The economic importance of the fish species on which research work was initiated was as follows:

Kind	Metric tons	Percentage of total of commercial fishery	Position in catch statistics of commercial fishery
Pelagic fish			
Roundscad	18,885	17.7	1
Anchovy	5,003	4.7	3
Mackerel	2,202	1.9	13
Total bag net fishing	41,395	38.8	
Demersal fish			
Slipmouth	16,594	15.5	2
Lizard fish	4,578	4.3	4
Nemipterid	3,807	3.6	5
Shrimp	3,702	3.5	6
Total otter trawl fishing	45,906	43.1	
Total commercial fishing	106,659	100.0	

The research on pelagic fish stocks deals with fish species caught mainly by the fast developing bag net fishery (bas-nigan) which operates by attracting fish schools at night by means of light; that on demersal fish stocks deals with the four most important types of fish of the otter trawl fishery. The research work deals with fish species which constitute some 51 per cent of the total catch of the commercial fishing vessels.

PELAGIC FISH

Anchovy or dilis (*Stolephorus* sp.)

The catch of anchovy ranks third in the total commercial fish catch. The record of an annual catch of 5,000 metric tons

(1956) in official reports probably does not reveal the real importance of the group because of the great deficiencies of the whole statistical system. The writer had an opportunity during a field trip of checking the Manila Bay landings of anchovy, which are given in the Fisheries Statistics as having been 722,462 kgs. in 1955, 499,071 kgs. in 1956 and 676,989 kgs. in 1957. He found that in the third week of April, 1958 along some 100 basnigans stationed at Salinas landed some 800,000 kgs. of anchovy caught in Manila Bay. He was told by fishermen that the catches were good for that time of the year, although larger catches were usually obtained during the rainy season. On the recommendation of the writer the Government will request technical assistance in this field from FAO.

A research programme on the economically important genus, *Stolephorus* Lacépéde in Manila Bay was started in November 1956. Research was concentrated on the possibility of increasing production without risking depletion of the stock.

Observations on the species, length, weight, sex, maturity, length and weight of gonads, fecundity, and abundance of parasites, were made on specimens taken every other week for five consecutive days from the Malate fish Market, and coming from known localities. Every sampling day samples of 2 kgs. each of unsorted catch were purchased from each banera of catch which obviously appeared different both in its length composition and in its catch composition by species.

Special taxonomic studies were initiated to determine the number of species, and special racial studies, to determine whether the stock of anchovies in the area being fished draws recruits from other areas and if so the magnitude of the exchange of individuals between areas. A team of eight workers is engaged in this research. Two to three are doing life-history research, two are making taxonomic and racial studies, and four are engaged in the statistical compilation of the data.

The attached "Chart of Monthly Progress of the Project" (Appendix 7.6) shows that during the period under review 397 samples were taken, 208,530 specimens were determined and measured, and of these 84,370 specimens have been studied in detail and 1,922 specimens for stomach content. Since October 1957 the fecundity of 16 specimens was determined in connection with research on the fecundity of different types of fish. Up to March, samples were collected only from Manila Bay and from Lucena. Since then sampling has been occasionally ex-

tended to ten other catching areas such as Batangas Bay, Lingayen Gulf, San Miguel Bay, Iloilo, Davao, Sibuguey, Albay, Sitio, Bohol, and Cotabato, and 81 samples were collected, 54,530 specimens were determined and measured, and 8,170 specimens were studied in detail.

With regard to the taxonomic and racial studies, 37 samples of 3,000 specimens of all nine *Stolephorus* sp. were checked as to the numbers of gillrakers on the epi-, cerato- and hypobranchial of gill arch; of scutes; of finrays of the dorsal, anal, caudal, pectoral and ventral, of vertebrae and of the total, fork- and standard lengths. Other 42 samples of 2,250 specimens were worked up as to number of gill-rakers on the epibranchial of gill arch; of scutes; of finrays of the dorsal, anal, caudal, vertebrae and of the total length only.

Although the investigations are being continued, many of the data collected until May 1957 have been compiled and will be published as a "Study on the biology of Philippine Anchovy of the Genus *Stolephorus* Lacépéde". The preparation of another paper "Racial studies on the Genus *Stolephorus* Lacépéde in Philippine waters" has been delayed because of some inaccuracies in the countings during the early part of this investigation which has made a rechecking of counts necessary.

The important results obtained so far are:

Identity.—Four new records of *Stolephorus* sp. in Philippine waters, of which one is possibly of a species still undescribed, could be added to the known five species. The species were determined as *Stolephorus zollingeri* (B)., *S. indicus* (B.), *S. tri* (B.), *S. commersonii* (L.), *S. heterolobus* (B.), *S. pseudoheterolobus* (H.), *S. baganensis* (H.), *S. celebicus* (H.), and *S.* (unknown). The exact determination of *Stolephorus heterolobus*, *S. pseudoheterolobus*, *S. baganensis* and *S. celebicus* from available keys and descriptions was found impossible. A new determination key for the Philippine species was prepared. From the many meristic characters studied, only the number of gill rakers proved of value for the clear distinction of species. Elaboration of a key based on materials of the whole Indo-Pacific Region is highly desirable. To begin with, an exchange of materials, Philippine specimens of all species have been sent to Indonesia.

Location.—(*a*) All species were found in Manila Bay but at different levels of abundance. *Stolephorus pseudoheterolobus*, *S. heterolobus* and to a large degree also *S. commersonii*, *S.*

indicus and *S. zollingeri* were frequently found in the samples taken during the research work. On the other hand, the other species occurred much less frequently. *Stolephorus baganensis* was found for the first time after 11 months of study in the 160th sample taken from Manila Bay catch, *S. celebicus* after 19 months, in the 327th sample, *S. tri* after 21 months in the 351st sample and the unknown species after 20 months in the 341st sample (only once). At the times that these less abundant species did appear they constituted usually a large proportion of the total catch of anchovy fishery over several consecutive days and even weeks. It can be concluded that the accessibility of the nine *Stolephorus* species to Manila Bay fishery is on the whole irregular. The appearance of anchovy stocks in Manila Bay may be seasonably regular in the case of *S. pseudoheterolobus*, *S. heterolobus*, *S. commersonii* and *S. zollingeri*, but is likely not bound to regular yearly cycles in the case of the other species. The most distinctive cycle of appearance was observed in *S. commersonii* which constituted 20–30 per cent of the total catch during the rainy season whereas before and after only from 0 per cent to some 7 per cent. Since the Manila Bay fishery exploits anchovy stocks which draw their recruits largely from an area extending outside the Bay, there seems to be little danger at the moment of depletion of the stocks.

(*b*) The availability of anchovy in Manila Bay is generally much larger during the rainy season. The fishes may be attracted then into the Bay by the rich food it offers. It has to be checked whether the anchovy stocks can be fished outside the Bay in those months when they are not to be found in the Bay.

(*c*) The different anchovy species probably have different tendencies to visit or stay in the Bay as has been observed from the respective minimum size of the caught specimens. The smallest specimens of *Stolephorus heterolobus* and *S. pseudoheterolobus* which were found in the samples measured 20–40 mm., of *S. zollingeri* not below 40 mm., of *S. commersonii* not below 50 mm., of *S. baganensis* not below 60 mm., of *S. indicus* and the new species not below 65 mm., of *S. celebicus* not below 70 mm., and of *S. tri* not below 90 mm. These findings may also have a certain bearing on the location of the spawning centers of the species. *Stolephorus zollingeri*, for example, was regularly caught in sizes between 20–40 mm. in Batangas Bay, from August 1957 to January 1958 where a second sampling

programme has been carried out. *Stolephorus indicus* was frequently caught in small sizes in Lingayen Gulf.

(*d*) The tendency of each species to mix with other members of the genus *Stolephorus* in Manila Bay was examined. The greatest tendency was found in *Stolephorus zollingeri* which goes together with *Stolephorus heterolobus, S. pseudoheterolobus* and *S. commersonii,* but very seldom with *S. indicus.* This was followed by *S. commersonii, S. heterolobus* and *S. pseudoheterolobus*. The least tendency to mix with other species was found in *Stolephorus indicus.*

(*e*) The question whether or not the *Stolephorus* species appear in mixed populations also in other fishing grounds was checked more thoroughly in Batangas Bay by weekly sampling over 11 months. These samples consisted almost purely of *S. zollingeri* and were only occasionally mixed with *S. pseudoheterolobus* and others. The anchovy resources can obviously be very different in neighbouring areas. The resource of Manila Bay has to be judged as the better resource if compared with that of the Batangas Bay since the fishery exploits not only one but many species so that low yields of one species could easily be offset by other species. Further investigations in this respect will contribute much to the adequate exploitation of local anchovy resources.

Bionomics and Population Characteristics.—(*a*) *Stolephorus* species are heterosexual. They reach maturity at different size groups. It is likely that first spawning takes place in the second year of life at a size of about 50–60 mm. (total length) in *Stolephorus pseudoheterolobus, S. heterolobus, S. zollingeri* and *S. baganensis;* and at a size of some 60–70 mm. in *Stolephorus commersonii, S. indicus* probably spawns for the first time at a larger size, which could not be determined because of the absence of smaller specimens in the collected materials. The rare species were not studied in this respect. There is evidence that the species spawn more than one batch of eggs during each season. The mature transparent oval eggs vary slightly in shape and size from species to species. However, their separation in egg catches is rather difficult and needs further study. The fecundity of the species is relatively low with some 5,000 to 15,000 eggs in one spawning season.

(*b*) *Stolephorus* species spawn in at least one of their length groups throughout the year. The available compilations of the first 18 months of the research period do not allow recognition of a distinct spawning cycle in any of the species, but rather

indicate that a distinct spawning season perhaps does not exist. The high spawning activity of *Stolephorus pseudoheterolobus*, for example, observed from December 1956 to March 1957, was not observed one year later. During December 1957 and January 1958 only a minimum of spawning occurred. The periods in which ten per cent and more of the mature specimens have been found to be in spawning condition were December 1956 to March 1957; June 1957; September 1957 to November 1957; and February 1958 to March 1958. Fully ripe gonads were found in less than two per cent of the specimen during May 1957; July 1957; January 1958; and May 1958. On the other hand, correspondingly in both years, 1957 and 1958, and also correspondingly in all *Stolephorus* species, little or no ripe gonads were found during April and May, the two driest and warmest months of the year. Future researchers should bear in mind to recheck the interesting observation that relatively low numbers of mature specimens in one species very often tallies with low numbers in others.

(*c*) *Stolephorus heterolobus*, *S. pseudoheterolobus*, *S. zollingeri* and *S. commersonii* spawn inside Manila Bay on the fishing grounds but it is unlikely that *Stolephorus indicus* does. This can be concluded not only from the determination of the maturity stages, but also generally from the egg catches made with a Hensen egg net (opening of 0.83m^2) in connection with the oceanographic survey of Manila Bay. The highest number of 685 eggs of anchovy under one square meter surface was caught at station B (see attached station map, Appendix 7.9.) in August 1957. During the research period from April 1957 to March 1958, the average rate of catch was highest at station B with 43.7 eggs per m^2 or 21.0 eggs per m^3; then follow station C with 16.5 eggs per m^2 or 4.9 eggs per m^3; station D with 16.1 eggs per m^2 or 3.2 eggs per m^3; station A with 6.8 eggs per m^2 or 5.4 eggs per m^3; and station E, the station most offshore, at which no anchovy egg was caught during the entire period. The spawning area has its centre in the centre of the Bay but considerably extends to the shallower parts outside the Bay. Most of the 2,504 anchovy eggs caught during the year were observed from June to August, during the first part of the rainy season.

(*d*) *Stolephorus indicus* was observed to have presumably the largest growth potential. The largest specimen measured 146 mm; that of *S. zollingeri* was 130 mm.; of *S. commersonii*

120 mm.; of *S. celebicus* 119 mm.,; of *S. tri* 104 mm.; of *S. pseudoheterolobus* 98 mm.; of the unknown species 88 mm.; of *S. heterolobus* 86 mm.; and of *S. baganensis* 72 mm.

(*e*) Since age determinations with the help of scales, otoliths, etc. have proven to be useless, an estimate of growth of *S. pseudoheterolobus* the most abundant species in Manila Bay, was made by means of the Petersen method. The length measurements of those specimens in which the sex remained undetermined were also used for this purpose after comparison of the length compositions of male and female specimens had shown no significant difference, but that probably in all *Stolephorus* species the sexes have the same growth rate. The estimate was based on 33 length frequencies, which were computed fortnightly from samples of several hundreds up to several thousands of measurements. The yearly growth rate was calculated to be roughly between 34 and 44 mm. *Stolephorus pseudoheterolobus* may reach a length of 34–44 mm. at the end of its first year of life, 68–88 mm. at the end of its second year of life and perhaps lives only three years. In the light of this estimate, which can be considered, however, only as a first attempt, this anchovy species probably spawns first in its second year of life and spawns at least twice during its life. It was observed that specimens which are younger than one year are caught only occasionally by "basnigan" in Manila Bay during the dry months from February to April and that specimens which are less than one to one-and-a-half year leave Manila Bay during the rainy season in which the salinity decreases below 26–28°/00.

(*f*) A regular seasonal rhythm with regard to the availability of different age groups to fisheries can be concluded for *Stolephorus pseudoheterolobus* and *S. heterolobus*.

(*g*) Presuming the correctness of the growth estimated it may be concluded that the young of *S. heterolobus* and *S. pseudoheterolobus* which leave the Bay during the rainy season probably return to the Bay correspondingly older. This could be interpreted as indication that both species form more or less local populations. On the other hand it is obvious that the young spend several months outside the Bay during which time they may migrate or be drifted to other areas. Also the fact that large numbers of anchovy eggs were found outside the Bay at station D allows the assumption that the population may spread over a larger area.

(*h*) Males were nearly always found to be slightly more abundant than females in *Stolephorus pseudoheterolobus* and *S. heterolobus*. During the first months of observation females dominated sometimes considerably in the samples of *Stolephorus indicus, S. commersonii* and *S. zollingeri*. Yet, a typical schooling by sexes can scarcely be concluded from available data.

(*i*) *Stolephorus* species are phyto-and zooplankton feeders and considerable number feed on their own eggs. The materials are still under compilation.

(*j*) *Parasitic copepods* attached near to the lateral line or near the dorsal fin were found occasionally in all species. The presence of Nematods was observed in the intestines. It is intended to send the unknown parasites abroad for identification.

Roundscad or Galongong (*Decapterus sp.*).

The roundscad is one of the very few fish in Philippine waters caught in large quantities most of the year. A special bag net fishery developed after the war in Palawan waters, Batangas, Balayan, Tayabas and Pangasinan Bays, in Camarines Norte, Ragay Gulf, and northern Zamboanga. This fish is the most important of commercial species, the catch amounting to 17.7% of total landings. The scads are small to moderate-sized, with flesh similar in taste and texture to that of chub mackerel.

The writer considers that this fishery should be further developed; although not "first class", the fish is popular with poor people because it is cheap and of good flavour. This fishery may prove to be the most important in supplying cheap protein food to the mass of the Filipino public.

Researches were initiated in November 1956. Three counterpart assistants are assigned to the biological research, one to the taxonomic research, two to the fat analyses and two to the statistical compilation of data. They deal mainly with the analysis of catch samples from known localities taken in the market because no research vessel could be engaged for systematic surveys of catching areas and because it was not possible to develop a sampling programme aboard commercial fishing boats because of lack of cooperation of "basnigan" owners. The researches were concentrated in the beginning on catches of Palawan waters, but in April 1957 the extension of the observations to the catches made in the Manila Bay approach became desirable.

Samples consisting of about 300 specimens of the unsorted catch were obtained mainly by purchase at the Malate fish market and brought to the laboratories for detailed analysis. Since February 1958 additional samples of all available catches were analyzed daily with regard to their composition by species and to their length composition directly in the market without purchasing them in order to complete the observations on the population structure of the fish stocks.

The attached "Chart of Monthly Progress of the Project" (Appendix 7.6) shows that since November 1956, 319 samples of *Decapterus* sp. from Palawan waters and other areas were collected on the Navotas and Malate fish market, 96,260 specimens were determined and measured, and 43,460 specimens were examined in detail; and 618 fat analyses were made to determine the yearly cycle of fat content of this typical tropical fish. Since May 1957, 479 analyses of stomach content have been carried out. Since October 1957, 49 specimens have been studied with regard to their fecundity.

In the taxonomic studies, 600 specimens in 25 samples were checked with regard to the number of gillrakers on the epicerato- and hypobranchial of the gill arch; of scutes and scales in the lateral line; of finrays of the first and second dorsal fins, of the caudal, anal, pectoral and ventral fins; of vertebrae.

The first results of this research will be published in a scientific report "Biological studies on roundscads (*Decapterus* sp. Bleeker) in Philippine waters", based on the data collected from November 1956 to July 1958.

The results obtained so far are:

Identification.—It is believed that only two species of roundscads of commercial importance can be distinguished in Philippine waters instead of three as generally assumed by previous authors. They are *Decapterus russelli* (Ruppell) and *Decapterus macrosoma* (Bleeker). The third species, *Decapterus kurroides* (Bleeker) is probably identical with *Decapterus macrosoma*. The characteristic broad variations in the measurements of meristic features as found in the genus *Decapterus* may have caused the existing confusion. *Decapterus kurroides* (Bleeker) which has been reported as a fourth species present in Philippine waters, but rare, was not rediscovered during the research.

Decapterus russelli and *D. macrosoma* are doubtless distinct in the number of scales along the lateral line (region from

head to the first scute - 51–66; 74–93); number of scutes (32–39; 26–32); number of finrays of second dorsal (30–33, I; 34–38, I); and length of pectoral in standard length (3.7 - 4.7; 4.9 - 6.3). *Decapterus russelli* has also a larger body depth and head length than *Decapterus macrosoma*. No characteristic differences which would permit a clear distinction of species were found in the number of vertebrae, of gillrakers and of other finrays.

Location.—(*a*) Fisheries in Palawan waters exploit chiefly *Decapterus macrosoma;* however, in Manila Bay approach, which is understood to reach from the mouth of Manila Bay to Batangas, the fishery exploits chiefly *Decapterus russelli*. In Palawan waters, only 0.3 to 4.1 per cent of the roundscad catches from April to November 1957 were *Decapterus russelli*. However, during the NE monsoon season from December to March/April in which the fishery shifts to the more sheltered W side of Northern Palawan, the catches were considerably mixed with *Decapterus russelli* at a rate between 21.8 and 66.8 per cent.

Although the collected data indicate that the centers of distribution of the two species probably differed during the period of research, further investigations will be necessary to check whether the distribution centres are fixed or shift to other areas within certain periods. It should also be investigated whether or not the stock of *Decapterus russelli*, which obviously was present in Palawan waters during the NE monsoon season of both years, cannot be utilized during the SW monsoon season outside the usual fishing grounds then.

(*b*) The fact that roundscads usually do not enter Manila Bay may be explained by the absence of suitable food organisms inside the Bay. The usual lower salinity of the bay waters perhaps may not fully explain the phenomena since roundscads avoid the bay even during the dry months when the salinity is the same inside and outside the bay. The main catching places are a little offshore, characterized by water depth below some 20–25 fathoms up to several hundred of fathoms like occasionally in Palawan waters.

Bionomics and Population Characteristics.—(*a*) The size of *Decapterus macrosoma* caught in bag nets varied between 68 to 296 mm., of *D. russelli* between 68 and 244 mm.

(*b*) A typical yearly cycle in roundscad fisheries of Palawan waters was observed from the size composition. Small juve-

nile specimens enter the fishery at its start in February to March and increase in length month by month. After one year they have nearly reached maturity and disappear, being replaced again by younger stocks.

(*c*) It seems to be typical that the dominant age group usually matures uniformly and slowly. From February 1957 to January 1958 the gonads developed from maturity stage I to II to stage IV to V [eight maturity stages were distinguished as described by Heincke and Maier (Bückmann, 1929; "Die Methodik fischereibiologischer Untersuchungen an Meeresfischen"; —In Abderhalden; Handb. d. biol. Arbeitsmeth., Abt. IX. T1.6.)]. The stock disappears from the fishery with the gonads not yet fully ripe for spawning. It will be one of the interesting tasks of future research to explore the possibility of greater fishing of those stocks which have left the fishery. It is possible that those stocks spawn and live in other unknown areas or also that they have greatly lost their positive phototaxic behaviour and cannot be attracted any more by the light fishery. The exact spawning time could not be determined because fully ripe specimens were not caught. It is possible that spawning takes place over a longer period starting in about November December and ending April/May. Spawning in several batches of eggs is likely.

(*d*) Researches on the fecundity of roundscads show that some 80,000 to 300,000 eggs are produced every spawning season, their number increasing with size. The ripe eggs have several, mostly four, oil globules and are 0.4 - 0.6 mm. in diameter in both species. So far these eggs could not be identified in the available egg catches.

(*e*) The size composition of samples of males and females is very uniform in both species. Growth difference between the sexes is consequently most unlikely. The yearly growth rate was estimated by means of the Petersen method to be about 40 mm. for specimens of both species which measure from 150 to some 170 mm. in total length. The age of roundscads which are caught in length groups chiefly between 150–200 mm. by the bag net fishery was estimated to be about three or four years. Farther investigations, especially on younger fish stocks, will be necessary to obtain more accurate results because the growth rate of younger specimens is greater.

(*f*) Special schooling in sexes was not observed.

(*g*) Nematode infection was studied in roundscads of the two areas. A considerably heavier infection was found in Palawan waters, indicating to a certain degree that the stocks of these areas are separate or have only little exchange.

(*h*) No characteristic differences were observed in the food composition of the two species. They are zooplankton feeders, feed seldom on phytoplankton, but very frequently on small fishes such as Dussumieridae. The investigations proved also that roundscad occasionally feeds on small bivalves and gastropods which live on the bottom; thus this otherwise pelagic fish, which during dark nights is attracted by strong light and can be caught on the surface in bag nets, must spend some time on the bottom, probably in day time, even if only occasionally. The question then arises as to whether it is possible to catch roundscad consistently at the bottom by otter trawl, as herring is caught by the European fishery. The answer seems to be that probably it could be since it is occasionally found in quantities of some 60–100 specimens in the otter trawl catches outside Manila Bay. Experimental fishing with light otter trawls similar to the European herring net could prove whether a new day fishery on roundscads could be established. If successful, this could prove to be of great importance because the existing bag net fishery can operate only during dark moonless nights, i.e. only a fortnight of every month.

(*i*) As was expected the fat content of roundscads does not display the seasonal cycle observable in fat fishes in the temperate waters. The fat content average 9 to 12 per cent in *Decapterus macrosoma* through the year. However, the individual differences are much larger. The highest fat content was found in a female specimen, 173 mm. in length, maturity stage II, with 19.5 per cent in August 1957, the lowest with 4.4 per cent in January 1957 in a female, 104 mm., maturity stage IV. *Decapterus russelli* shows a similar but somewhat higher fat content. Although roundscads obviously form a basis for a fish oil production, they cannot be considered as an excellent raw material if compared with the European oil herring or other fat fishes. In Europe a herring of fat content less than 12–15 per cent is considered unprofitable raw material for the production of fish oil.

Chub Mackerel or hasa-hasa and alumahan (*Rastrelliger* sp.)

The Chub mackerel ranks 13th in the commercial fisheries with a total catch estimated at 2,200 tons in 1956 or 2.1% of the total production. The mackerels are of moderate to large size, with

excellent flesh. *Rastrelliger* research is strongly recommended by the Indo-Pacific Fisheries Council and a Regional Research Programme aided by Technical Assistance may be initiated on the recommendation of the Council. An International Training Center on the Methodology and Techniques of Research on Mackerel (*Rastrelliger*) took place in Bangkok, Thailand from 20 October 1958 to 28 November 1958, organized by FAO, in cooperation with the Government of Thailand, the Indo-Pacific Fisheries Council, and the participating governments of the Indo-Pacific. The Philippine Government was represented by three participants recruited from the staff of counterpart assistants.

In December 1956 the work of the Bureau of Fisheries of the last few years was resumed. The high price which the fish demands presented a great handicap in carrying out a sampling programme. For this reason and because of the forthcoming International Training Center in which the coordination of research activities was to be discussed, the work was limited to some preparatory questions on the proper identity of species and the population structure of the stocks in Manila Bay and Palawan waters.

Since December 1956, 207 samples of 13,070 specimens of *Rastrelliger* sp. have been collected and preserved. From these, 9,820 specimens have been examined. In August 1957 the programme was extended to measurements made in the Malate market. Some 17,930 length measurements were taken since then (compare Chart of monthly progress of the project, Pos. Nos. 17–24; Appendix 7.6).

Some 700 specimens of *Rastrelliger* sp. were investigated with regard to the number of gillrakers of the epi-, cerato-, and hypobranchial of the gill arch, of finrays of the first and second dorsal fins, of the pectoral, ventral, anal and caudal fins, of the dorsal and ventral finlets; of the vertebrae, to the total-, fork- and standard length to the body depth, head length, height of first dorsal and pectoral fins.

The research staff consists of two to four workers.

The important results are:

Identity.—Comparison of Philippine fishes with Indonesian obtained in exchange, shows that probably the two species present in these waters are the same. They are: *Rastrelliger neglectus* (Van Kampen) 1907 or hasa-hasa and *R. kanagurta*

(Cuvier) 1829 or alumahan. *R. neglectus* is identical with *R. brachysoma* (Bleeker) and *R. kanagurta* with *R. chrysozonus* (Ruppell). The only characteristic difference which permits the exact separation of the two species was found to be body height, which is 3.0 - 3.7 times in standard length for *R. neglectus* and 3.6 - 4.7 times in standard length for *R. kanagurta*.

Location

(*a*) The observation of previous workers that *Rastrelliger kanagurta* is an open sea form and *R. neglectus* an inshore form was confirmed. However, during the period of research the juvenile stages of *R. kanagurta* were frequently observed inside Manila Bay.

(*b*) The Manila Bay fishery uses immature fish stocks exclusively. Maturity is reached at a size not below 165 mm. in *R. neglectus* and probably not below 180 mm. in *R. kanagurta*. Fish with fully ripe gonads were not observed, neither in Manila Bay samples nor in samples of other localities. The highest maturity stage found was No. IV.

(*c*) In spite of the use of a miscroscope the accurate distinction of sexes was found to be impossible in juvenile specimens. Histological investigations are greatly desirable.

(*d*) Schooling in size groups is very evident. Schooling in sexes is possible, although only few data could be gathered on this point because the largest part of the samples consisted of juvenile specimens and because the high costs of mature fishes precluded purchase of more samples.

Tuna.

When the writer arrived in the Philippines in October 1956 he surveyed the facilities for tuna research. He found that equipping of the "M/V *David Starr Jordan*" for tuna longline fishing had been delayed by several months, and the first trip took place only in February 1957. Only two m* working space was available on board for the scientific staff because it was necessary to increase the number of the crew members from six to about 20 in order to handle the longlines.

It was evident that this vessel was too small to develop a tuna research programme and that it would be impossible to use it to demonstrate the methods applied in marine fishery biological research. Indeed, in May 1957 the Director of Fisheries, being afraid it would capsize, prohibited its use after

* total length

the second trip of the typhoon season. Two further trips were made in November 1957 and February 1958.

In April 1957 one of the counterparts returned from tuna trap observations at Paluan Bay, Mindoro, and reported that the selling of tunas had been prohibited because of cases of tuna poisoning. Thus, since fishing had stopped, tuna research became impossible.

On the occasion of the visit of the Japanese research vessel S.S. "Shunkotsu-Maru", the expert participated in a short demonstration trip of tuna longline fishing in waters north of Lubang Island, 1–3 February 1957, to give three of his counterpart assistants training in the biological and hydrographic investigations for tuna. From 6–17 February, from 23 March–12 April, from 20–30 November 1957 and from 16–28 February 1958 one to two of his counterparts joined the four tuna longline operations aboard the "M/V *David Starr Jordan*" to Mindoro Strait, West Panay and Palawan waters, initiated by Ma. Suzuki, to make scientific observations. The trips were limited to eleven catch operations because of bad weather. The 14 tuna caught were studied with regard to length, weight, number of finrays, finlets, stomach content, sex maturity stage, etc., but unfortunately there were too few fish to yield any new data on the biology and distribution of tuna in Philippine waters. The hydrographical data collected during these trips was also insignificant.

Many length measurements of tuna were collected by another counterpart who was assigned in Paluan Bay, Mindoro, from 18 December 1956 to 15 February 1957, and from 23 March to 6 April 1957, to observe the catch composition of the local trap net fishing. But this fishing was stopped because of tuna poisoning.

Demersal fish

Demersal or bottom fish stocks are fished mainly by otter trawling. It is at present the most important commercially with landings of 45,910 metric tons in 1956, or 43.1 per cent of the catch of registered commercial fishing vessels of more than three tons gross. The aggregate investment in boats and gear is estimated by the Bureau of Fisheries at about 10 million pesos. For several years the fishery has been a cause of controversy between different fishing groups as to whether or not it causes depletion of the stocks.

It is stressed here that present research activities must be regarded as only a start because the controversy demands the most detailed research. The trawl fishery exploits stocks of 98 species from 30 families of fishes. Not a single species is caught in abundance sufficient to sustain a distinct fishery.

Research begun in November is being carried out mostly in Manila Bay. By January 1957 it was fully developed and provided a means of special training of counterparts, since all samples were collected aboard commercial fishing boats. The data obtained allow more detailed interpretation than those gathered in the research in pelagic fish species, which were mostly sampled from local fish markets.

Since no research vessel was available to catch samples in Manila Bay, the expert obtained the collaboration of fishing boat operators, from November 1956 onwards, and 43 field trips of three to five days each were made. Two or three counterpart assistants participated in the study of the length distribution of different species, catch composition, collection of fish samples for detailed study in the laboratories, locating catch positions, determining water temperatures and in collecting water samples for the determination of salinity in surface and bottom water layers at each haul station of the trawl net.

The expert participated in the first operation aboard the fishing boat "Leonor" (13–16 November 1956) in order to train four counterpart assistants in taking fish samples, etc.

In a study of the distribution of fish stocks in the coastal areas shallower than eight fathoms, catch samples (41 in number) of fish corrals were taken from Navotas after January 1957 and experimental fishing by means of a typical baby trawl was organized in April 1957 along the Manila Bay coast between Cavite and Bataan.

Research was extended to San Miguel Bay in the first instance from 21–30 July, then from 23 September to 7 October 1957, from 13–28 February and from 21 May to 4 June 1958, one to three workers being sent out with all necessary equipment. In cooperation with commercial fishing boat owners, they also carried out survey work on the hydrography, plankton, benthos and primary production. The operation was initiated to provide a basis for a more comprehensive study of San Miguel Bay with regard to the otter trawl controversy, and to determine whether research in distant localities could be carried out from the central research station in Manila, or if the establishment of

sub-stations would be necessary. Last but not least, the work was undertaken to assist in the interpretation of certain phenomena in Manila Bay.

FIG. 2. Station Map of San Miguel Bay

In connection with the last survey the expert visited San Miguel Bay area from 4–9 June 1938 to check the researches

being conducted and to locate a suitable place for the establishment of a sub-station which it was thought might become necessary for the proper development of the undoubtedly rich fish resource. An ideal place was found in Mercedes, near Daet in Camarines Norte, a rapidly developing fishing place which is the centre of basnigan fishing. The locality is especially favourable for extensive researches on roundscads and other species, and for bottom fishes since one of the widest trawling grounds of the Philippines is located there. The place is perhaps also the most favorable for intensive shrimp investigations.

The writer would like to stress, however, that the establishment of any sub-research station depends mainly on the availability of suitable staff. He believes that the members of the staff now formed need two more years of practical experience in research work in a closely managed programme before any of them could be sent to work independently in a substation. After visiting the so-called "'Oceanographic Station" in Lucap, Hundred Islands, which is unequipped and unmanned, the expert does not favour the idea of using it as fisheries research station. The station is located too far from any important fishing centre to be useful for applied fisheries research.

Slipmouth or sapsap Leiognathidæ.

Leiognathidæ species are the most abundant of demersal fishes in Manila Bay and in most of the other areas. In 1956, 16,590 metric tons were landed -15.5% of the total catch of commercial fisheries.

Researches mainly deal with the availability of slipmouth stocks and its accessibility to commercial otter trawls, baby trawls and fish corrals. These stocks have proven to be the most valuable material for research in connection with the otter trawl controversy in which fish corral operators allege that the trawl fisheries are depleting the demersal fish stocks and have proposed a total ban on trawl fishing in Manila Bay and other areas.

From November 1956 to September 1958, 175 samples were taken aboard commercial fishing boats in Manila Bay and San Miguel Bay and 232,330 specimens of 17 species were determined and measured. Of these 86,120 were examined in detail. Since April 1957, 1,275 specimens have been examined for gut content. Since October 1957, 41 specimens were checked with regard to fecundity.

Morphometric data were collected on 700 specimens of the different species with regard to the number of gillrakers of the gill arch, of finrays of the dorsal, pectoral, ventral, anal and caudal fins, and of vertebrae; to the total-, fork- and standard length, head length, body depth and eye diameter. The body depth of 3,600 specimens was measured.

From January 1957 to June 1957 and from October 1957 to June 1958 at Navotas, Leiognathus catches by fish corrals were investigated for comparison with the other trawl catches. Forty one samples of 76,400 specimens were determined and measured; of these 5,100 were examined in detail (compare chart of monthly progress of the project, Pos. No. 25–34; Appendix 7.6).

Since April 1957, Leiognathus catches of the baby trawl operation were analyzed. 579,910 specimens of 652 catches were determined and measured.

The present research staff consists of three biological workers and two statistical.

The materials collected from November 1956 to June 1958 are nearly compiled and interpreted and will be published in the scientific report "Biological investigations on slipmouths or sapsap (family *Leiognathidæ* Lacépéde) of commercial otter trawls, baby trawls and fish corrals in Manila Bay and San Miguel Bay."

The important results are:

Identity.—17 species of Leiognathidae can be distinguished, from which the presence of *Leiognathus smithursti* (Rams. and Ogilby) in Philippine waters was previously unknown. The other species are *Gazza minuta* (Bl.), *G. achlamys* (J. and St.), *Leiognathus ruconius* (H.B.), *L. insidiator* (Bl.), *L. elongatus* (Gthr.), *L. fasciatus* (Lac.), *L. leuciscus* (Gthr.), *L. equulus* (Forsk.) *L. blochii* (C.V.), *L. brevirostris* (C.V. [Day]), *L. dussumieri* (C.V.), *L. splendens* (Cuv.), *L. bindus* (C.V.), *L. daura* (Cuv.), *L. lineolatus* (C.V.), and *L. berbis* (C.V.). It is still in doubt whether *L. blochii* and *L. brevirostris* are two species or only one, and also whether *Gazza minuta* and *G. achlamys* are not the same. A new determination key was prepared because of several controversial views in previous keys.

Location.—(*a*) Most of the species were observed to be present in Manila Bay and San Miguel Bay. *Leiognathus lineolatus* and *L. berbis* were found only in Manila Bay samples, and *L. dussu-*

mieri, L. smithrusti and *L. fasciatus* were observed only in San Miguel Bay samples.

(*b*) In both areas the four most abundant species were *Leiognathus splendens, L. bindus, L. ruconius* and *L. insidiator. L. elongatus, L. berbis* and *L. brevirostris* were found only very rarely.

(*c*) Comparison of the catches of the three different gears under study in Manila Bay shows that the weight share of slipmouth species on the total catch was highest in the fish corrals, amounting to more than 80 per cent in 12 out of 13 months and in eight months to even more than 90 per cent; the weight share was lowest in the commercial otter trawls with 5.1 to 36.5 per cent (exceptionally 67.7 per cent in November 1957). The weight share of slipmouth in the catches of the baby trawl made in the same area in which usually fish corrals are operated was found to amount to 52.4 - 87.2 per cent. It is obvious that the fishery in the areas shallower than 8 fathoms (especially the fish corrals at Navotas) almost completely depends on slipmouth stocks, contrary to the commercial otter trawls which chiefly catch species which avoid the shallower parts of the bay.

(*d*) *Leiognathus splendens* was observed to be the most abundant *Leiognathus* species in the fish corrals. Referring to the number of specimens, 73.1–98.4 per cent of the *Leiognathus* catch consisted of *L. splendens*. Other Leiognathidae such as *L. bindus* and *L. insidiator* enter fish corrals in large schools only occasionally, although they are present in the fishing area as could be proven by the baby trawl operation. Some species, e.g. *L. ruconius* and *L. daura* apparently are not being caught to a larger degree by fish corrals, in spite of their large accessibility to baby trawl gear.

(*e*) The length composition of catches by the three different gears index study was compared. A dominant cycle in the accessibility of age groups to the different gears was observed in *Leiognathus splendens*. In April and May of both years, at the beginning of the SW monsoon season which causes the end of the fish corral season at Navotas, young fish of *L. splendens* appeared in coastal areas and replaced the older fish stocks of previous months in this area. They were caught by the baby trawl fishery. Until October, at the start of the NE monsoon season and of the fish corral season at Navotas, the young fish stocks had increased in average length from 25

mm. to aout 45 mm. In the following months, this age group was fished by both the fish corrals and the baby trawl. At the same time, the commercial otter trawl fishery caught older fish. In March April 1958 the stocks fished until then by the fish corrals and the baby trawl fishery moved to the deeper areas and became part of the catches of the commercial otter trawl fishery. They replaced a stock of older fishes which had been fished from July 1957 to February 1958 by the commercial otter trawls which probably entered the bay also in March/ April 1957, at an average size of about 40 mm. This age group was for the first time caught near the mouth of Manila Bay at 24 fathoms by the commercial otter trawl fishery in March 1957, yet it was mainly found in the baby trawl catches during April and May 1957 from which it disappeared in June 1957. In February 1958 the fish had reached a length of about 95 mm. in the deeper parts of the bay.

It is unlikely that of the young age groups found in the baby trawls in May 1957 one is a whole year older than the other. They probably represent two different broods separated by only four months. The fact that both groups entered Manila Bay at the one time and not at different times but at the same age may perhaps be explained by the prevailing monsoon. The NE monsoon of previous months may have prevented the older group from entering the bay earlier.

(*f*) The distinct differences found in the distribution of the different age groups of *Leiognathus splendens* in both areas were found also in *L. daura*, *L. lineolatus* and *L. ruconius*. Also *L. bindus* was observed to appear in considerably smaller size groups in the shallower parts than in the deeper parts, yet a distinct cycle in the availability of different age groups could not be demonstrated perhaps because the accessibility of this species is seasonal and because generally it is not present in the shallower areas. The length composition of *L. insidiator*, which was found to be much more abundant in the deeper areas (as *L. bindus*), did not differ much between the two areas, although the occasional observation of a younger year class was limited to the baby trawl area.

Bionomics and Population Characteristics.—(*a*) The sex ratio, calculated monthly for each of the species, shows that the males were slightly more numerous than the females in *L. splendens*, *L. lineolatus*, *L. blochii* and *L. equulus* while the reverse was found in *L. bindus*, *L. insidiator* and *L. ruconius*. In most of

the species females were relatively more abundant in the rainy season than during other seasons, a fact which is yet unexplained!

(*b*) The average length of females of all species was found to be slightly larger than that of the males Although the females probably grow faster than the males, the difference is probably less than 5%.

(*c*) An attempt was made to determine yearly growth rate by means of the Petersen method using all available length measurements and ignoring the difference indicated between the sexes which in any case is negligible in young fish. The clearest picture was obtained in *Leiognathus splendens* which increased its length from about 25 mm. in May 1957 to about 75 mm. in May 1958, with weight increase of some 7.55 g. Similar growth rates are probable for *L. insidiator* and *L. ruconius*. The materials collected for the other species did not permit a clear interpretation.

(*d*) It is probable that most of the *Leiognathus* sp. reach maturity after their first year of life and that they spawn for the first time at about eighteen months.

(*e*) The most developed ovaries were found to be in stage V, in which the first transparent eggs are visible, but not yet fully rounded and not extrudable. Ovaries of this stage were observed frequently in *L. splendens, L. insidiator, L. daura* and *L. blochii* and mainly during the first half of the year, especially a short time before the disappearance of larger length groups from the catches. Stage V was not found at all or only very rarely in *Leiognathus bindus, L. ruconius, L. lineolatus, L. leuciscus, L. equulus* and in *Gazza* sp. Although it may be possible that some of the species spawn to a small extent inside the bay there is much evidence that the greater part of the stock spawns outside the bay, outside the fishing grounds. Since the spawning stock could not be observed the main spawning time could not be determined; some evidence suggests that it may be between January and July, but it is possible that spawning is almost continual throughout the year, and that there is no main spawning season.

This result, being similar to that obtained in other demersal fish stocks under study, shows that regulation measure intended to protect spawners on the fishing grounds of Manila Bay and other bays would serve little purpose.

(*f*) It is possible that each spawner sheds several batches of eggs in the year. The number of eggs counted in ovaries of stage IV or V varied between 5,800, in a specimen of *L. ruconius* (56 mm. in total length) and 79,100 in a specimen of *L. bindus* (113 mm.). The differences in the fecundity of the species are still under study.

(*g*) *Leiognathus* sp. are zoo- and phytoplankton feeders grazing a large variety of food organisms. Some of them, especially *L. splendens*, also frequently feed on benthonic foraminifera and other benthonic food animals. As expected, *L. ruconius* and *L. insidiator*, both having an upward directed mouth tube contrary to the other species, can obviously not use benthonic food. Scales and fish bones are found not infrequently in the gut content, and fish eggs are frequently eaten. The largest feeding intensity was found in *L. splendens* whose diet also includes the largest variety of food organisms. Differences in the gut content of specimens caught in Manila Bay and San Miguel Bay were observed, deriving chiefly from the availability of food animals in those areas.

(*h*) The number of slipmouths caught by the commercial fisheries amounted during 1956 and 1957 to roughly 220 million in Manila Bay, and to some 2,500 million in the whole Philippine Archipelago each year. These figures show that the numerical strength of this group stands comparison with those of species fished in temperate waters. The difference lies as in many other fish resources of the Philippines, in that the average size is small (somewhat less than 6 g.)and thus the slipmouth biomass on the limited trawling grounds is not great. A catch per hour of only 2.29 kg. slipmouth was made by the Manila Bay trawlers in the average of 1,216 fishing hours recorded from November 1956 to July 1958. The total catch per hour of the trawlers was some 12.92 kg.

Threadfin Bream or Bisugo (*Nemipterus sp.*).

The threadfin bream is the fifth in importance commercially. In 1956 landings were 3,810 metric tons or 3.6 per cent of the total catch, caught mainly by the trawl fishery.

As it is difficult to distinguish the 18 species recorded in the Philippine waters, especially under working conditions aboard, the research initiated in November 1956 was concentrated only on *Nemipterus japonicus* which is easily recognizable. Taxonomic studies were not included in the programme owing to lack of staff.

Since November 1956, 181 samples of 42,820 specimens of *Nemipterus japonicus* have been determined and measured. Sixty eight samples of 13,510 specimens were collected, preserved and studied in detail in the laboratory. Since the start in April 1957 of investigations into the stomach content, 229 specimens have been checked since October 1957.

A scientific report "'Biological observations on *Nemipterus japonicus* (Bloch) in Manila Bay" is in preparation.

The main results are:

Location.—(*a*) *Nemipterus japonicus,* the most abundant species of this genus, inhabits chiefly the parts of the bay deeper than 8 fathoms, like all members of this group. It is fished practically only by the commercial otter trawlers. It was found only occasionally in catches of baby trawler and fish corrals in small size groups not observed in the deeper waters. The recruits to the Manila Bay stock probably do not live in the bay.

(*b*) Species of this genus are found only rarely in San Miguel Bay area in contrast with the situation in Manila Bay.

Bionomics and Population Characteristics.—(*a*) The fish was caught in sizes between 5 and 25 cm., the monthly average size was between 11 and 14 cm.

(*b*) The size of male and female specimens was found to be rather similar although in a few months the males were slightly larger.

(*c*) The yearly growth rate was estimated by the Petersen method to be about 5 cm. in a group that grew from about 9 cm. in March 1957 to about 14 cm. in March 1958. The stock being fished consists of at least 3 or 4 years classes, which can be identified by peaks in the length curves with confidence only in the lower age groups.

(*d*) Schooling by sexes is unlikely although one sex can considerably outnumber the other for long periods of several months.

(*e*) Maturity is reached at a size of about 10–12 cm. 113,100 eggs were estimated in a specimen measuring 120 mm., and 221,200 in a specimen of 161 mm.

(*f*) Fully mature ovaries were found in samples of July, September, October and December 1957, but these were only few in number. Although spawning activity to a small extent was observed in the deeper parts of Manila Bay near the bay opening, it is likely that main spawning occurs outside the

bay and with a climax, in 1957, during the months from June to October. However, it is felt that larger materials of specimens above 125 mm. should be sampled to check this finding. The first spawning probably takes place within the third year of life.

(*g*) *Nemipterus japonicus* is a typical zoo- and phytoplankton feeder with a broad range of food items. Occasionally it feeds on fish fry such as anchovy and slipmouth.

Lizard fish or kalaso (*Synodontidæ*).

The lizard fish catch of 4,580 metric tons, or 4.5% is fourth in the landing statistics. The fish is caught mainly in the trawl fisheries. *Saurida* sp. is probably first in abundance in the trawl fisheries in the South China Sea, recently developed by fishermen from Hongkong, Formosa and Southern Japan. This research may become more important if and when Philippine fishing boats participate in these fisheries.

Since November 1956 research has been conducted by a worker sent by Professor Nemenzo, Head of the Department of Zoology, University of the Philippines, to write his M.Sc. thesis under supervision of the expert. During 54 field trips 229 samples of 52,400 specimens of *Saurida tumbil* and *S. gracilis* were determined and measured in Manila Bay and San Miguel Bay.

Eightynine samples were collected in these two areas and preserved, and 80 samples of 12,570 specimens were checked in the usual way and with regard to stomach contents. Taxonomic data were collected from 300 specimens including counts of gillrakers, vertebrae and finrays of all fins. Fecundity of six specimens was determined.

The results from the data obtained up to June 1958 which will be published in a paper "Observations on the biology of *Saurida tumbil* (Bloch) and other members of the family Synodontidae in Philippine waters" are summarized in the following paragraphs:

Identity.—(*a*) A key was prepared for the Philippine species of the family Synodontidae, which include the known six species—*Trachinocephalus myops* (Forster), *Synodus similis* (McCulloch), *Synodus variegatus* (Lacépéde), *Saurida tumbil* (Bloch), *Saurida gracilis* (Quoy and Gairnard), *Saurida undosquamis* (Richardson). There is a seventh, still undescribed species or type, which is similar in colouration to *Saurida*

gracilis, but in its high number of vertebrae resembles *S. tumbil*, and may be a hybrid of these species.

Location.—(*a*) All species were found to be present in Manila Bay and, except *Saurida undosquamis*, *Synodus variegatus* and *S. similis*, also in San Miguel Bay area. However, only the species of Saurida are of commercial importance, and of these especially *Saurida tumbil*, *S. gracilis* and *S. undosquamis* only occasionally. The species of the other genera are rare.

(*b*) Lizard fishes were found to be rare in the baby trawl catches and obviously avoid the shallower parts of the bay. They have their area of main distribution in waters deeper than 15 fathoms, *Saurida gracilis* and the rare species of the family stay even deeper than 20 fathoms. Like Nemipterus, the rich resource of lizard fishes consequently can be fished only by the commercial otter trawl fishery.

Bionomics and Population Characteristics.—(*a*) *Saurida tumbil* probably grows largest of all species of Saurida. The biggest specimen found in the samples measure 45 cm. The largest specimen of *S. gracilis* measured 28 cm. and that of *S. undosquamis* only 16 cm. in total length. In all these species, in nearly all samples, the average size of females was greater than that of the males by up to 3 cm. in the two smaller species and up to 5 cm. in *S. tumbil*. The size difference between sexes was observed to be larger in waters deeper than 20 fathoms than in the shallower area.

Specimens smaller than 8 cm, were observed only rarely in the catches. Therefore it is possible that the young fish of Manila Bay stock live outside the bay.

(*b*) Strong schooling by sexes in certain months and areas is obvious. There were months in which the samples collected were more than 90 per cent up to 95.7 per cent males (in October 1957). In nearly all months in waters deeper than 20 fathoms males of *Saurida tumbil* and *S. gracilis* dominated considerably, while females of *S. undosquamis* usually were much more abundant. In the shallow waters, the females were relatively more abundant than in the deeper as indicated by a more balanced sex ratio.

(*c*) The growth rate was estimated by means of the Petersen method although its application involves special difficulties in *Saurida* sp. if based on measurements of specimens regardless of their sex, since the sexes probably have different growth rates and there are considerable differences in sex ratio with locality

and time, even though the accelerated growth rate of the female is probably not more than 10 per cent of that of the male.

However, the size of materials in which the sex was determined proved to be too small to be used for this purpose.

Saurida tumbil was observed to have grown from 8 cm. in November 1956 to about 21 cm. in August 1958 which is equivalent to a yearly length increase from some 7.5 cm. Specimens which measured 20 cm. in November 1956 reached a length of some 29 cm. in May 1958 being equivalent to a yearly length increase of about 6 cm. The length increase of 7.5 cm. (from 8 cm. to 15.5 cm.) is equivalent to a weight increase of 23.7 g. (from 3.9 g. to 27.8 g.) and that of 6 cm. (from 20 cm. to 26 cm.) corresponds to a weight increase of 74.1 g. (from 58.7 g. to 132.8 g.).

Growth rates could not be calculated for the other species because of the small amount of material.

(*d*) Most of the *Saurida tumbil* catches consist of specimens which are in their second to third year of life. Four-year-old specimens are rare and usually live only in the mouth of Manila Bay. Fluctuations in recruitment to Manila Bay stock were indicated by the fact that fish of age less than two years were much less numerous in 1958 than in 1957. In 1958 the fishery concentrated on a stock which had already been heavily fished as two-year-olds in 1957. Since the older age groups stay in the deeper parts of the bay the general scarcity of lizard fishes in the shallower areas observed in 1958 by the commercial fishery may be well explained by this finding. On the other hand, overfishing is unlikely.

(*e*) The females of *Saurida tumbil* reach maturity at a length of about 20 cm. being approximately in their third year of life. The males at a length of about 15 cm. at an age similar to that of the females. Running testes were observed in nearly every month. It is denoted that the spawning grounds are in Manila Bay since fully ripe females were rare and limited in their distribution to the deeper waters in the mouth of the Bay. A major spawning time cannot be identified from available data, which have proven to be inadequate especially with regard to the number of large females studied because of the very unbalanced sex ratio found in the catches made in the deeper waters. In the future, larger and more numerous samples, especially of size groups above 20 cm., should be collected.

Saurida gracilis matures also at a size of about 20 cm. and

S. undosquamis at about 10 cm. These species also do not spawn in Manila Bay to any great extent.

(*f*) 366,000 to 647,000 eggs were counted in ovaries of *Saurida tumbil* measuring 21–27 cm. in total length. Spawning in several batches of eggs is likely.

(*g*) Lizard fishes are predators feeding on different kinds of fishes, including their own young, squids and larger crustaceans. Their food animals were found in sizes which correspond from one third to one half of their own size. Most abundant food fishes are anchovies, gobies, slipmouth (especially *Leiognathus insidiator*), *Acetes*, squids *Apogon*, *Platycephalus*, shrimp species, *Sardinella* and *Nemipterus*.

Shrimps.

Shrimps with 3,700 metric tons or 3.5 per cent come sixth in the commercial landings, but much higher in value, since they command the highest price of any fishery product. Shrimps are caught mainly in the trawl fisheries.

The research initiated in November 1956 was limited in the beginning to questions of distribution in the Manila Bay. In April 1957 a Bachelor of Science in Zoology graduate of the U.P., was assigned to check the preserved specimens collected during the commercial otter trawl operation. He concentrated mainly on food investigations in order to test the hypothesis that the abundance of shrimps in certain fishing grounds may possibly depend on the availability of food animals. As second research area the San Miguel Bay known as excellent fishing ground for shrimps was chosen and sampling was extended there in connection with the other research activities.

Experiments in tanks of 2 x 2 m. were initiated to study the moulting behaviour. Unfortunately, the investigations, which are of importance in determining the growth rate, had to be discontinued after the first promising results because of lack of suitable research conditions. Since the new physiological laboratory could be fully equipped only shortly before the departure of the writer, the experiments were not continued during his stay.

In July 1958, a special weekly sampling programme was initiated in San Miguel Bay with the aim of studying the composition of shrimp catches taken in the so-called shrimp baklad for 1958 catch season. The samples are being preserved in formalin and will be sent to Manila. This research is directed towards determining whether there is conflict of in-

terest between the baklad operators and the commercial otter trawl fishery and to analyze the nature of those interests.

Since November 1956, 427 samples of 74,720 specimens were determined and measured during 54 field trips in Manila Bay and in San Miguel Bay. Checking of the 45 samples preserved during the operation is underway, while 4,690 specimens have been studied in detail with regard to their total length, carapace length, rostral length, the number of rostral spines and segments of the olfactory branch of the first antenna and to their spawning conditions. The stomach and intestine content of 241 specimens was researched.

The data will be compiled for a paper: "The diet of some Philippine shrimp species (Genus *Penæus and Metapenæus*) in Manila Bay and San Miguel Bay in correlation with the availability of food animals" and for another: "Investigations on the age composition and distribution of shrimp species (Genus *Penæus* and *Metapenæus*) in Manila Bay".

The preliminary results are:

Identity.—(*a*) The most abundant commercial shrimp species in the catches of the otter trawl fishery in Manila Bay are *Metapenæus monocerus* (Fabricius) and *Penæus monodon* Fabricius or *Penæus semisulcatus* de Haan. The others were recently kindly identified by Mr. T. Butler, FAO Fisheries Officer in Indonesia, as *Penæus indicus* Milne Edwards, *P. merguiensis* de Man, *P. canaliculatus* Olivier, *P. latisulcatus* Kishinoye, *Metapenæus novæ-guineæ* (Haswell) and *Parapenæopsis cornutus* Kishinoye. Taxonomic work on the whole group was first recently initiated so that other species may still be discovered.

The catches of the *alamang* fishery with scissor nets (sakag) do not include the larvæ of the important commercial species, but those of *Acetes* sp. of the family Sergestidæ.

In San Miguel Bay area, the most abundant species being caught by the otter trawl fishery are *Penæus indicus* and likely *P. merguiensis*. Second to these species are *Metapenæus monoceros* and *P. monodon*. The others which were found until now are *P. canaliculatus* and *Metapenæus dobsoni* Miers.

(*b*) *Penæus monodon* or tiger shrimps or sugpo is caught in sizes between 7 and 26 cm., *Metapenæus monoceros* between 5 and 21 cm. Manila Bay stock is fished only by the commercial otter trawlers. It is not yet known whether the baklads which catch shrimps in the San Miguel Bay fish the same species as

the commercial otter trawlers. Researches in this respect have been initiated.

Bionomics and Population Characteristics.—(*a*) Considerable differences in growth rates were observed between the two species and also sexes. By means of the Petersen method a yearly length increase of 4 cm. was calculated for female *Metapenæus monoceros* which measured in February 1957 some 10 cm. At the same time the males grew only 2.5 cm. While the females increased their weight by 14.5 g., the males had a much smaller weight increase from only 4.9 g. *Penæus monodon* had the larger growth rate; the yearly length increase was estimated roughly to be some 7 cm. in the females which measured in April 13.5 cm. in total length and some 3–4 cm. in the males. The corresponding weight increase amounts in the females to 49.2 g. and in the males to 18.2 g.

(*b*) A more direct method for determining the growth rate of shrimps developed by the expert in connection with researches on Crangon was applied in this Philippine programme. The method is based on the fact that the number of moultings through which a Crangon has passed can be concluded from the number of segments of the external branch of its first antenna. Although it was not possible to develop fully a research in this respect, because of technical difficulties in keeping the shrimps under constant research conditions, one female specimen of *Metapenæus monoceros* was kept over three successive moultings. Comparison of the three exuvia obtained showed that the number of segments of the olfactory part of the external branch of its first antenna increased by one segment at each moulting from 37 segments to 38 to 39. Also the number of segments on the distal part of the external branch of the first antenna increased by one from moult to moult, from 39 to 40 to 41. This single result indicates the possibility of using the technique applied in Crangon research to check growth rates of Philippine shrimps calculated by means of the Petersen method.

(*c*) The faster growing *Penæus monodon* is cultivated in ponds and previous researchers have found that under the optimal conditions of salt water fishponds the species can be brought from fry stage to a weight of some 100 g. within one year. It is believed that shrimp production could be considerably increased if only females were cultured, the males being separated and rejected. This can be done successfully

only if the sugpo fry is kept in nursery ponds for about 6–12 weeks until the individuals reach a minimum size of 80–100 mm. at which sex dimorphism, which first appears at some 50 mm., is distinctly recognizable with the naked eye.

(*d*) Shrimps caught in commercial otter trawls are possibly only of a single year class which remains only one year in the bay. In *Penæus monodon* the replacement of the older stock by a younger stock took place in both years, in about April/May in *Metapenæus monoceros* somewhat later, in about June/July. The recruits perhaps enter the fishery at an age of 6–12 months.

(*e*) The shrimp stocks probably leave the fishing grounds to spawn outside the bay. No spawning was observed inside the bay. It is possible that the spawning grounds for *Penæus monodon* may be found to be not far offshore since its fry can be caught in many places along the coast in size groups of only 15 mm. The fry enters the estuaries of Manila Bay.

(*f*) The sex ratio of the commercial shrimp stocks is more or less balanced and no schooling in sexes has been observed.

(*g*) The commercial shrimp species feed on phyto- and zooplankton, but mainly on benthonic foraminiferans of some 40 different genera and other benthonic animals, such apolychaets, pelecypods, amphipods, gastropods and others. They feed occasionally also on small fishes, fish eggs and on decapod crustaceans. Since all species feed on a large variety of food specimens, it has not yet been possible to determine whether differences in feeding habit exist.

(*h*) The difference in shrimp production between San Miguel Bay area and Manila Bay can be explained by the difference in the availability of food animals for the shrimp. San Miguel Bay, being the much better producer of benthos biomass than Manila Bay (see index 4.33), is also the better shrimping area, with a yield of 3.5 kg. per fishing hour (the average of 228 fishing hours) than Manila Bay in which the average shrimp catch amounted to 0.98 kg. only (the average of 2,016 fishing hours). Benthos researches are highly desirable in connection with future shrimp surveys. Since the average night catches in Manila Bay were found to be twice the day catches it is possible that the Philippine shrimp species have behaviour similar to that of the European shrimp species, *Crangon vulgaris*, which hides in the mud during daytime. Experiments should be made in this respect on the different species with the aim of increasing day catches by using some slightly heavier

ground ropes in the trawl nets during the day fishery, in order to scare the shrimps from their hiding places.

Prospective and comparative fishing (*baby trawl operation*).

This research was initiated in connection with the otter trawl controversy. It is directed towards determining the distribution of demersal fish stocks in the shallow coastal parts of Manila Bay in which fish corrals, etc. are operated. This was to supplement the observations being made in the commercial otter trawl fishery, normally operated in water of more than ten fathoms. It also supplements that being carried out on the biology of demersal fish species.

With the cooperation of the Superintendent of the PIFT, Mr. Pidlaoan, a motor boat was made available for this work in April 1957, and was then equipped with a small otter trawl similar to that used in the "baby trawl" fishery. Two counterpart assistants, with two crew members of the J-boat, made 21 one-day field trips, trawling systematically in six areas along the western coast of Manila Bay between Cavite and the Pampanga River, on the two- and five-fathom depth lines.

Since September 1957 the operation has been continued with the new motor banca, on the two-, five- and eight-fathom depth lines. A comparison of catches of certain species in Manila Bay is therefore possible in following depth steps: 2 fathoms, 5, 8, 10–15, 15–20 and 20–30 fathoms.

Since October 1957, apart from the standard net with mesh size of ¾ inch in its cod end, additional nets of mesh sizes of 1¼, 1½, 1¾, 2, 2¼ and 2¾ inches were used to investigate the selectivity of these mesh. One of the six fixed stations was visited on every field trip and two sets each of three 30-minute drags were made on two, five and eight fathoms, one set each with the standard net and one alternately with one of the additional gears.

Since the beginning 140 field trips were made. All catches were preserved and analyzed in the laboratory and 579,910 specimens of 652 samples (net hauls) were determined and analyzed. At present five workers are assigned to the sampling survey, these and one to the laboratory, and two for the statistical work.

The species and length composition of catches made up to May 1958 is being determined and interpreted in connection with the other researches. The catches consisted of some 150 different species, mainly belonging to the slipmouth group,

secondly to the families of Apogonidæ, Gerridæ, flatfishes, Triodontidæ and many others. It is recommended that this work should be continued as long as researches on demersal fish stocks of Manila Bay are being conducted. The value of such data cannot be over-estimated if yearly fluctuations in catch composition must be analyzed and predicted. Results obtained on species other than those being specially studied, and the overall results relating to the entire community should be published on completion of three years of continuous survey.

The compilation of the findings made with respect to the selectivity of different mesh sizes are not yet terminated. The first findings show, however, that the catch considerably decreases in total number and weight of specimens if mesh sizes larger than 3/4 inch are used in the cod end.

Mesh in cod end	Number of drags	Average number of fish	Weight in grams
3/4"	135	1,872	3,660
1 1/4"	99	598	1,250
1 1/2"	4	125	920
1 3/4"	27	221	1,460
2"	14	58	460
2 1/4"	7	24	250
2 3/4"	18	14	190

Differences in the size composition of catches of *Leiognathus splendens*, which were caught with the 3/4 and 1 1/4 inch mesh, were found to be non-significant. First with mesh sizes of 2 inches and larger the catch of fishes below 4 cm. could be successfully avoided while the 1 3/4 inch mesh still caught fishes of the smallest size group between 2 and 4 mm. as found in the standard net although in a much more favourable proportion to the bigger ones.

One should be aware that the introduction of minimum mesh sizes of 1 1/4 inch or larger in the baby trawl fishery of Manila Bay which may be considered as necessary some day would result in the loss of livelihood for the fishermen during the rainy season when they practically depend on fishing with small mesh sizes. During the other part of the year most of them now already use larger mesh sizes for the catch of blue crabs and other crustaceans.

The necessity to consider the introduction of minimum mesh sizes in the commercial otter trawl fishery, which uses mesh sizes of 1 1/4–1 1/2 inch is doubted very much since only the

younger age groups are available on the fishing grounds and most of the species do not attain larger sizes on the fishing grounds.

The baby trawl operation and research on demersal fish species carried out in the commercial otter trawl operation are complementary. Since May 1957 research in the commercial otter trawl operation was extended to fish species found in abundance in the baby trawl catches, and 214 samples of 45,670 specimens of *Apogon, Gerres, Pentaprion* and *Pomadasid* species were measured.

The results show that the younger age groups live in the coastal shallow parts of Manila Bay.

OCEANOGRAPHIC INVESTIGATIONS

Hydrography.

Hydrographic observations were made in connection with the commercial otter and baby trawl operations. Water temperature readings and salinity samples were taken in surface and bottom water layers at each net hauling station. Further hydrographic data were collected in connection with special research into the distribution of plankton (since April 1957) and of benthos (since August 1957). From 1,258 hydrographical stations, 2,085 temperature data were collected, 2,169 salinity, 412 oxygen, 76 pH, 401 phosphate and 173 transparency data.

Four workers are assigned to collecting and analyzing the data.

The data have been compiled and are being used for the interpretation of biological findings. They will be published as raw data in the "Reports of Raw Data of the Philippine Fisheries Research Center" which will be edited in mimeographed form in a short time, as recommended by the writer. It is also intended to publish the results in a paper "Further observations on the Hydrography of Manila Bay, 1957-1959" at the end of the second year of observation, in April 1959.

Plankton.

Investigation of the distribution of plankton was started in April 1957, after arrival of plankton nets from FAO, Rome, with special regard to the fluctuations in the availability of food animals to the fish stocks and to the distribution of fish eggs and fish larvæ in and around Manila Bay.

Five stations in and outside the Manila Bay were visited each month by the "M/V David Starr Jordan" (fig. 1). The visit to station E, far outside Manila Bay, was not possible in April, August 1957 and in June and July 1958 because of bad weather.

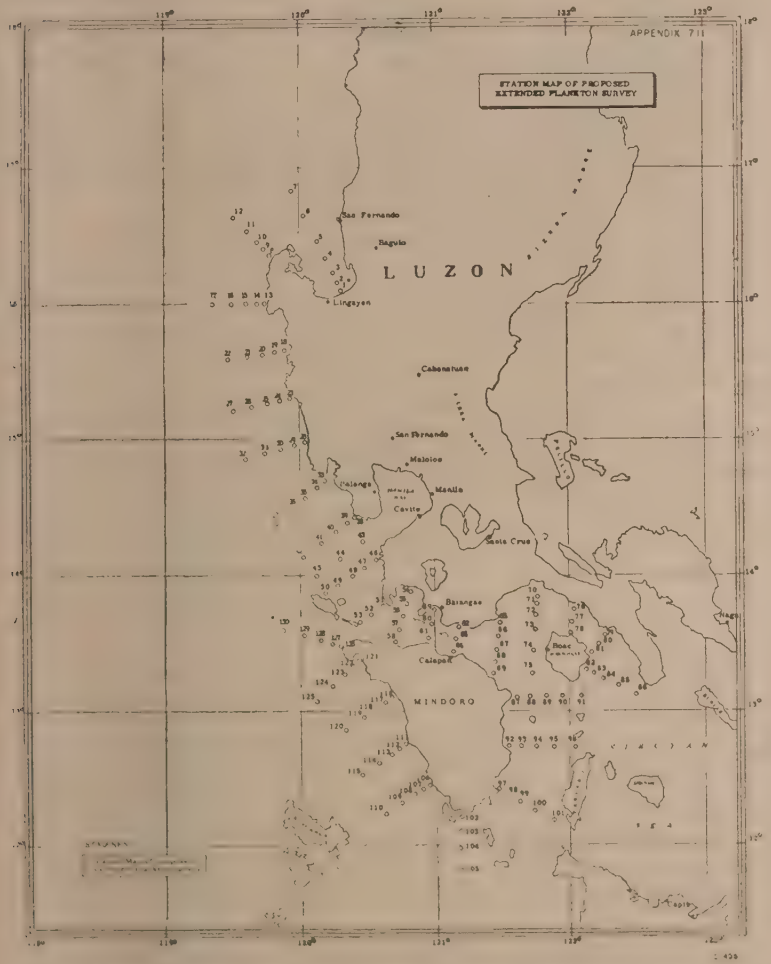


FIG. 3. Station map of proposed extended plankton survey

Nineteen field trips were made in Manila Bay, and the expert took part in four of these; 90 stations were covered. Three vertical hauls with a Hensen egg net and usually, one ten-

minute horizontal drag with a ring trawl were made at each station. In all, 274 vertical and 90 horizontal catches were carried out, 268 of these were roughly sorted and determined. Lack of literature hindered identification of species and, frequently, even genus and family. Research was extended to the San Miguel Bay in connection with the other researches and samples were systematically taken at three fixed stations. Thirty-nine samples were collected in September 1957, February and May 1958. Research was occasionally extended to other sampling areas, such as Batangas Bay and Lingayen Gulf.

Since September 1958, special research on phytoplankton has been carried out in connection with the study of primary production (compare 3.34).

Two graduates of the University of the Philippines who are writing their M.Sc. thesis were assigned and trained in these researches; one of these was awarded a five-year scholarship to Japan and left in May 1958. Another graduate of the U.P. took her place. In February 1958, two additional workers were assigned.

Analysis of samples (identification and enumeration) was confined to materials collected during the first year of survey at station B in the centre of the Bay and at station D outside the Bay. The data, whose compilation is near to completion, will be published in a report "Planktonological studies in Manila Bay area during the period from April 1957 to March 1958." Other findings on the distribution of fish eggs such as of *Stolephorus* are being incorporated in reports of other researches.

The following observations were made: (*a*) Plankton abundance was found to be richer inside Manila Bay than outside. A non-standard Hensen egg net with an opening of 73 cm. ring diameter, with a double layer of parachute silk because of lack of plankton bolting cloth material No. 3, caught on the average, from 104 vertical net tows made at stations A, B and C from April 1957 to March 1958, 34.3 cm^3 m^{-2} (SX 4.2 cm^3 m^{-2}) plankton biomass, and on the average, from 63 net tows at stations D and E, 23.4 cm^3 m^{-2}. Catches were highest in the center of the bay at station B with 42.5 cm^3 m^{-2}, followed by stations A with 30.6 cm^3 m^{-2}, C with 29.2 cm^3 m^{-2}, E with 25.6 cm^3/m^2 and D with 21.7 cm^3/m^2.

(*b*) Based on the average of the 104 plankton tows made at stations A, B and C, whose average depth corresponds with the

average depth of the bay (27 meters), the average standing crop of plankton in Manila Bay was calculated to be some 59,000 metric tons. But, since the calculation is based on the catching power of the Hensen egg net with parachute silk, this figure represents a minimum value. It was found that the parachute silk was extremely unsatisfactory. A set of six control hauls made with a net with plankton bolting cloth No. 3 in September 1958 gave catches on the average 167 per cent greater than parachute silk catches or, in other words, that the net with parachute silk caught only 38 per cent of the catches made with the bolting silk. Considering the error which entered the estimation of plankton standing crop the corrected average plankton standing crop of Manila Bay amounts to at least 157,000 metric tons, equivalent to 1,160 kg ha. Yet, the production of plankton biomass is much higher since the observed large changes in the catch composition and the biological turn over of the different plankton species has not been considered in the estimate, and since most of the micro-plankton organisms and also many of the larger forms will have escaped from the net.

(*c*) The relative abundance of phyto- and zooplankton differed greatly at stations inside and outside the bay. For instance, phytoplankton was 58.5 per cent of the catch at station B and at station D only 42.2 per cent. The absolute abundance of zooplankton was found to be larger at station B with 17.4 cm^3/m^2 than at station D with 12.6 cm^3 m^2.

(*d*) Plankton catches inside the bay were above average in June, October, December 1957, March 1958 and were maximal in June 1957 with 122.8 cm^3 m^2 in the average of 9 vertical tows taken at stations A, B and C. The largest of these tows was taken at station B and amounted even to 349.4 cm^3 m^2 The high catches were caused by a magnificent bloom of *Chaetoceros* (in the average 12.7 mill. m^2), of filamentosus algæ (7.7 mill. m^2), *Thalassiothrix* (6.0 mill. m^2), *Rhizosolenia* (1.1 mill. m^2). But also other plankton organisms were more abundant than in any other month, such as *Richelia* (634 Thous. m^2), *Hemiaulus* (575 th. m^2), *Nitzchia* (399 th. m^2), *Oscillatoria* (150 th. m^2), larvæ of Sea Urchins (120 th. m^2), *Ceratium tripos* (112 th. m^2), *Ditylum* (86 th. m^2), *Noctiluca* (56 th. m^2), *Thallassiosira* (44 th. m^2), *Eucampia* (26 th. m^2), *Ceratium fusus* (15 th. m^2), *Pelecypods* (896 th. m^2), *Vorticella* (398 th./m^2).

(*e*) It has so far not been possible to detect any correlation between the plankton abundance and the abundance of fish stocks in the bay. However, it seems that the rich phytoplankton bloom of June 1957 gave the base for the bloom of Copepoda, an important source of fish food observed in July and the following months, in which the fish catches were found to be generally higher than in the previous months.

(f) The comparison of the plankton samples collected at stations B and D, which were sorted in some 150 groups of organisms shows considerable differences in the distribution area of some of the plankton organisms. The following forms were found to be absolutely much more abundant outside than inside the bay: Thalassiosira, Asteromphalus, Liptocylindrus, Lipthodesmium, Asterionella, Achnantes, Nitzschia, Spirulina, Pedastrium, Ditylum, Treposelinia, Sagocena, Globorotalia, Nodosaria, Bulivina, Distophanes, Vorticella, Planula larvæ Pleurobrachia, Annelids, Sagitta, adult Gustropods, Pteropods, Clione, Cypris larvæ, Amphipods, Coryceaus, Oncea, Copilia, Sapphirina, Microsetella, Macrosetella, Squilla, Euphausia, Megalopa larvæ, Lucifer Zoea larvæ, Sand Dollar larvæ, Pluteus larvae, Salpa and others. On the other hand most of the detected plankton groups are mainly distributed inside the bay. A plankton calendar for Manila Bay area is in preparation. But here again, it will be necessary to investigate and to describe the differences which likely occur in different years as to both the magnitudinal and the compositional side.

Benthos

A benthos survey with a Petersen bottom grab received from FAO, Rome, in Manila Bay was initiated.

In August 1957, 67 different stations in and outside the Bay have been occupied by the "M/V David Starr Jordan". In September, nine stations of these were selected for continuous monthly collection of each three bottom samples. Since the beginning up to June 1958 (when the loss of both available bottom grabs caused the discontinuation of the survey) 333 bottom samples were taken and sieved. The sieve remains were preserved for laboratory examination. All samples are roughly sorted.

Research was extended to San Miguel Bay in September 1957. Since then 32 different stations were surveyed in September 1957, February and May 1958, and the sieve remains of 68 samples analyzed in the laboratory (compare attached station map

in fig. 2). A graduate of the U.P. who is writing his M.Sc. thesis has been assigned to this work.

A paper "The benthos biomass of Manila Bay and San Miguel Bay and its seasonal changes" is in preparation.

The following observations were made.—(*a*) Manila Bay and San Miguel Bay differ greatly in their production of benthos biomass. Only 0.741g 0.1m² biomass were found in the average of 260 Manila Bay samples of the nine standard stations, but 7.957g 0.1m² in the average of 57 San Miguel Bay samples of the 15 standard stations. The standard errors of the two means are respectively Sx= 0.0845 and Sx = 2.3171. In the average 3.5 animals per 0.1m² were obtained in Manila Bay, 5.8 in San Miguel Bay. Most of the 917 animals caught in Manila Bay were small errantian polychaetes of families Polynoidæ, Nerreidæ and Glyceridæ (364), followed by small macrurans (225), brachyurans (Macrophthalmus) (75), sedentarian polychaetes (53), ophiuroids (53), amphioxus (48), amphipods (31), pelecypods (24), echiuroida (20) and archiannelids (20). Only three alive gastropods were caught. The composition of bottom samples of San Miguel Bay is principally different. 191 animals of the total catch of 330 were sedentarian polychaetes mainly of family Terebellidae, 43 pelecypods, only 27 errantian polychaetes, 26 ophiuroids, 11 brachyurans, 9 nemertins, 6 macrurans, 4 echiuroids, 4 gastropods, 3 amphioxus. The differences found in the abundance of foraminiferans are still under study.

The different composition of benthos fauna in both areas results in the difference which was observed in the average weight of caught organism, 0.21g. in Manila Bay and 1.37g. in San Miguel Bay.

(*b*) Both areas were subdivided according to the nature of their substratum in zones of grayish mud, greenish mud, sandy mud and sand. In Manila Bay benthos biomass was with 1.08g. 0.1m² highest in the zone of grayish mud, followed by the sandy substratum (0.95g.), the greenish mud (0.59g.) and the sandy mud outside the bay (0.40g.). In San Miguel Bay most biomass was found in the greenish mud zone in the centre of the bay (13.1g.) then in the sandy mud in its east side (6.8g.), greyish mud (5.9g.), in the sandy substratum near the mouth of the bay (4.2g.), and lowest production was observed in the sandy mud of its west side (1.2g.).

Seasonal changes were observed to be compositional and magnitudinal; however, conclusions can hardly be made by the available data.

(*c*) It is believed that the larger productivity of benthos biomass in San Miguel Bay may have a certain bearing to the fact that flatfishes and shrimps are much more abundant there than in Manila Bay. Investigations into the food of flatfishes should be initiated to prove, as it has been demonstrated for shrimps, that also they depend on bottom organism. The relatively low productivity of the bottom in tropical waters may explain the finding that most of the abundant fish species are plankton feeders.

(*d*) Although Manila Bay (1.350 sq. km.) is 2.6 times larger than the San Miguel Bay (520 sq. km.) the standing crop of benthos biomass of San Miguel Bay is about 4 times as high as that of Manila Bay. Basing on the average catch of biomass, a standing crop of some 10,000 tons was calculated for Manila Bay and of some 40,000 metric tons for San Miguel Bay, or respectively 74.1 kg/ha and 795.7 kg/ha.

(*e*) There is no evidence that trawl fishing influences the bottom fauna as believed by certain fishermen. Benthos biomass was found in similar quantities in areas in which no trawling is being done.

Primary Production.

Researches to determine primary production by means of the radioactive C_{14}-techniques, were initiated in February 1958. This was possible through the kind cooperation of Dr. Maxwell Doty, Department of Botany of the University of Hawaii, who made the necessary equipment and materials of carbon isotope available and kindly offered to have counting of B-radiation of the collected samples done by his staff. The research will give indications of the relative fertility of different areas which may considerably help programmes for rational use of these resources, but it should be stressed that the research can at the present stage only supplement other standard observations since the interpretation of its results has not been fully clarified.

Research is being carried out in Manila Bay and in San Miguel Bay. In Manila Bay, 40 stations were occupied during March, May, July, August and September 1958. Since July, samples are taken at three different depths, whereas before, samples were taken only from the surface. Altogether 69 samples plus additional 138 control samples were treated by the standard procedures. In San Miguel Bay, 25 stations were covered in February and May 1958, amounting to 33 samples plus 66 control samples. All materials were sent to the Univer-

sity of Hawaii and, except the materials of the first two research months, are still being checked. One worker has been assigned. After completion of a one-year cycle the data will be correlated with those of other researches, such as into plankton, hydrography, fisheries productiveness, etc.

The first results obtained so far indicate in general that the carbon uptake of phytoplankton is high in the bay water. The measurements varied between 4,158 and 16,516 $mg^c/hr/m^3$ in the San Miguel Bay samples in February and between 2,280 and 12,714 $mg/hr/m^3$ in Manila Bay samples in March. The productivity rates were generally found to be higher in the shallow coastal areas than in the deeper offshore parts of the bay. Values of this magnitude were to be expected since average fisheries production of Manila Bay has been estimated to be about 62 kg. per hectare in 1956. The estimate was based on the catch figure of some 8,381 metric tons as given above by the Fisheries Statistics for the commercial fisheries and does not include the landings of the municipal fisheries and sustenance fishing in Manila Bay.

After having operated the baby trawl boat for more than 18 months it is possible to estimate the average catch per annum of one of the 1,500 baby trawlers operating in Manila Bay to at least 10 metric tons or to roughly estimate the total catch per annum of all baby trawlers being at present the most important group of fishermen in Manila Bay to some 15,000 metric tons. It is therefore believed that the total fish production of Manila amounted to at least 20–25,000 metric tons in 1957 which corresponds to a production of 150–180 kg./ha. And yet most of the catches of the bag net fishery and the catches of some 1,000 fish corrals, of the gill nets, push nets, lift nets, hook and line, of the dynamite fishery, etc. are not included, although there is no doubt that the trawl net is the most important gear utilizing the rich resource of the bay. Manila Bay is apparently one of the best developed aquatic resources of the world and can only be compared in its productivity with the Wadden Sea extending along the coast of the Netherlands and Germany.

The general conception that tropical waters are poor in fisheries productivity can obviously not be applied to the bay waters which have a much higher productivity than for example the European North Sea as a whole, being one of the richest fishing grounds of the world and having an average produc-

tivity of 26.4 kgs. per hectare (1948) only. Fishing areas like the Manila Bay are rare in the Philippine Archipelago but the Manila Bay may give an excellent example how much such fishing places can be developed if modern gears, such as the otter trawl and the bag net, are used for the exploitation of the resource. The concentration of research activities in this area and its importance is easily understood under the aspect that a unique opportunity is given to consider the exploitation of Manila Bay as one of the most suitable experiments to gain adequate knowledge into the proper and possible utilization of other coastal fisheries resources.

DISCUSSION AND CONCLUSIONS

It will be appreciated from the foregoing account of his assignment that Dr. Tiews had ample opportunity of examining local problems, assessing the means available for research, and of forming conclusions on the directions in which research should be prosecuted in future, and on the methods by which this should be done. His conclusions arranged below, chiefly under the headings referred to on page 112, are preceded by some general conclusions relating to the program as a whole.

GENERAL

The review of the history of research in the Philippines reveals that in fact a very considerable amount of research has been carried out from time to time, but this effort has been expended by different individuals and at different times. There has been little continuity, so that each piece of research has been an independent operation carried out virtually *de novo*, needing to traverse previously covered ground in order to arrive at its point of attack. The expert would place very great emphasis on the importance of the establishment of a comprehensive overall view of the problems confronting Philippine fishery workers and of the program that should be prosecuted to solve these problems. He would place equal emphasis on the desirability of the maintenance of continuity in the research work so that each piece of work should have an organic relation with and derive strength from the work that preceded it in the same field and from work in related fields.

The expert formulated his initial research program on the assumption that further knowledge of the resources was necessary for development of the fisheries and for their successful management. His experience during his assigment enabled him

to particularize within this very broad generalization but he was conscious of the disability under which he suffered because of the lack of economic research and the inadequacy of technological research, as a result of which it was scarcely possible to make a correct evaluation of the various situations existing in the country. In certain cases it has been assumed that industrial expansion is possible and the evidence from resources seems fairly strongly in support of such an assumption. However, a different view might appear if an effective analysis were made of economic and technological factors. The point which the expert wishes to make is that the program he has formulated is in general directed toward completing the array of information concerning Philippine fishery resources and that it is only in exceptional cases that he has been able to indicate, on the basis of characteristics of industrial situations, a strongly selective line of research to be prosecuted in order to answer particular industrial problems. He would emphasize the desirability of further development of the fishery services of the Philippines, especially on the economic side, so that decisions concerning governmental activities and in particular those concerning research might be well founded.

STAFF AND FACILITIES

It is impossible to make too much of the importance of the competence and numerical adequacy of the staff of a research program. The expert has devoted the major part of the time of his assignment to training local staff and he emphazises that steps must be taken to ensure that the trained staff should be retained in research and provided with the means of continuing their investigations. They should also continue to be assisted to improve their qualifications and arrangements should be made to attract and train other workers. Reference must be made to the general inadequacy of emoluments in much of the Governmental service, and, in particular, in the Fisheries Bureau. Unless better rewards are offered the Bureau will have difficulty in retaining its staff. At the same time it must be noted that the failure to arrange for the regular payment of the staff at present engaged is a seriously disrupting feature of the present service.

The expert encountered considerable difficulties during his assignment in connection with the procurement of funds for the operation of the research program. He was obliged frequently

to make strong representations for the allocation of funds from various sources and was consulted concerning the preparation of a budget for 1959–60. He emphasized that this budget, which is given as Appendix 7.1 represents the minimum of needs for the Bureau.

In the course of his activities the expert found that administration of the research centre as part of the normal operation of the Fisheries Bureau, within its administrative, developmental and regulatory functions was, at times, unable to cope with the exigencies and emergencies of the research program. In his view a research program should be formulated, financed and administered within some context other than that of the regulation and management of the industry. The allocation of funds to different parts of the research program must be on principles differing substantially from those which guide the allocation of funds within an administrative program; research work should not be placed in constant competition with the day to day political needs of administration. Furthermore, a research program inevitably throws out from time to time the special problems of operations which have no representation in the administration program. He therefore is of the view that it would be desirable that the present Division of Fisheries Research should be treated as the nucleus around which to construct a fisheries research centre which, although connected with the Bureau of Fisheries, for policy matters should have an independent budget and separate administration. There is ample precedent for an arrangement of this kind in countries whose fisheries are well developed.

Whilst the expert found that the premises provided for fisheries research, chiefly at the Dagat-dagatan Saltwater Experimental Station, were admirable in many respects and excellently located, they are nevertheless insufficient for the full range of investigations proposed in section 5.3 below. He would propose that a special building be constructed for research in hydrography, plankton, benthos and primary production, and another for brackishwater research. He also believes it necessary to provide a lecture hall, more suitable storage for oceanographic equipment, a workshop, and a dormitory for some of the workers and for guest research workers. A footbridge across the Malabon River is urgently needed. The expert also believes that if these researches should be centered on this station it would be appropriate to change its name from the

Dagat-dagatan Saltwater Experimental Station to "The Dagat-dagatan Fisheries Research Station".

As mentioned in various places through this report, special consideration should be given to the needs of the station with respect to research vessels. In the expert's view the station should be provided with two vessels: one for experimental trawling and the other for research on pelagic stocks. He has considered whether the M/V. "David Starr Jordan" would be suitable for these purposes and, whilst believing that it could be used as a trawler, nevertheless the overhaul necessary and the need to replace its engine probably mean that a better course would be to acquire a new vessel.

Publication of the results of research is an important element of a research program, beyond the obligation to inform other workers in that publication is itself one of the rewards of research and, at the same time, is a means of obtaining outside critical appraisal of the value of such work. Furthermore an institution's publications may be used to obtain literature from other institutions, on exchange. At present scientific reports of Philippine research can be published in the "Philippine Journal of Fisheries" and probably this provides a sufficient outlet for substantive reports. However, the expert considers that the station should establish a special series, in nonpermanent (mimeographed) form, for quick dissemination of bulky raw data, such as station lists.

THE IDENTIFICATION OF PROBLEMS

General.

In general the problems of the primary phase of Philippine fisheries fall into the familiar three main categories. There are those firstly, of the resources of which relatively little use has been made and to which fishing operations should be extended. Secondly, of resources which have been subjected to substantial exploitation and adjustment of operations is certain to increase efficiency or to prevent the onset of undesirable characteristics. Thirdly, of resources which have been subjected to fishing intensity at levels such as to induce undesirable characteristics in the stocks and hence in the industry itself. The expert believes that the pelagic resources generally fall into the first category, with some of the demersal resources that most demersal resources of Manila Bay fall into the second

category and only a few demersal resources, of Manila Bay, might fall into the third category. He holds this view in the face of the controversy surrounding certain Manila Bay resources. The importance of biological information varies as between these categories and the kind of information required differs from one to the other, ranging from questions of identification of species, through determination of location, to the description, analysis and prediction of fluctuations in magnitude of the stocks and changes in distribution pattern.

Correct identification of such problems is itself part of the research program and must be participated in by economists and technologists. Above all it requires accurate statistical information on landings and fishing effort. Unfortunately the statistical system is both inadequate and inaccurate and there has been very little economic or technological research in the Philippines. In consequence it is impossible to make authoritative diagnosis of the fishery situations, many of which constitute arenas for bitter controversy. One such is the fishery for anchovy concerning which there is a battle between two different groups of fishermen; another is that of the demersal stocks in Manila Bay with regard to which the fishermen operating fish corrals are in conflict with those who fish these stocks by trawling. Whilst it is legitimate to propose that these two particular instances should have priority among established investigations, the expert emphasizes that the stage of knowledge regarding these stocks is essentially much the same as that relating to other stocks, so that the pattern of investigations required for these must, at the present juncture, be approximately the same as that for species which are not so much a matter of controversy.

The expert has concluded, therefore, that for the present the best course of action is to formulate a fairly comprehensive program of research that would seek to establish an account of the principal characteristics of each species and to prosecute these researches with the utmost vigour, whilst making arrangements for constant appraisal of the results. At the same time steps should be taken to develop statistical services and to establish economical and technological research so that in the near future a review of the biological findings could be made in conjunction with an examination of statistical, economical and technological findings. More precise determination of biological investigations required could then be possible.

Current Levels of Exploitation and Methods of Fishing.

As indicated in the text, many lines of research were initiated during the expert's assignment, and definitive results have already begun to emerge. These will in due course be presented in properly prepared papers, and the conclusions which they permit concerning the resources and their exploitation will be fully substantiated in those papers. For the present the expert offers the following conclusion concerning certain major resources.

Since exploitation of the anchovy, which constitutes one of the richest resources available to Philippine fishermen, could be much further developed, the expert considers it undesirable to regulate mesh sizes in the bag nets of the basnigan fishery, as proposed by certain groups of fishermen, until systematic studies have been made on the response of these stocks to such regulations. It could well be that the proposed enlargement of the mesh size of bag nets from 1.0 cm. to 2.0 cm. (stretched mesh) would make it impossible to continue to use the anchovy resource fully, especially the smaller species, which are first in abundance. The assumption that such a regulation of mesh sizes would lead to an increase of anchovy catches is obviously erroneous since the small anchovy of Manila Bay are not identical with the young of those anchovy species which attain larger sizes, such as *Stolephorus indicus, S. commersonii* and *S. tri.* The catches of small anchovies are apparently from an independent resource.

It is evident that there would have been no advantage to the fish corrals of Navotas if Manila Bay area had been closed to trawl fishing during 1957 as was proposed in Congress hearings, since the stocks taken by the "baklads" are replaced every year by entirely new stocks. These stocks enter the commercial otter trawl fishery only after being fished by the baklads. On the contrary, it is obvious that the baklad fishery affects the catches of the commercial otter trawl fishery since it fishes these stocks when younger. However, for the moment it is believed that the effect is of minor importance because the gear is used only during certain months of the year and is small scale fishing in nature.

Like the small fish corrals the newly developed but rapidly developing baby trawl fishery operates in the shallower parts of the Bay within the depth range of 2–5 fathoms, and consequently with certain small meshes cannot avoid taking younger stocks. If necessary the catch of young fish could be prevented

by the introduction of minimum mesh sizes. Today, most of the baby trawlers in Manila Bay already use a mesh of two inches (stretched meshes) in the bag, for the first six months of the year (December to May, to catch blue crabs (alimasag) and to avoid catching small fish. This practice has proved to be a successful conservation measure on the part of the baby trawlers.

Fisheries policies in temperate countries normally tend to regulate the catch of the younger age groups of fishes, if necessary, in order to take some fish some time later after they have gained weight. However, the situation in Manila Bay and other fishing areas apparently does not allow application of regulations of this kind because there are no suitable offshore trawling grounds. There is reason to believe that in many fishing areas like Manila Bay only the younger age groups of most of the demersal fish are accessible to the fishery. Therefore, it appears wise and reasonable to use these young stocks fully until means can be found to catch the older fishes when these go to deeper water. Moreover the escape of the large fish to deeper water serves as a self-regulating factor in conservation of these stocks.

Since in any period the male shrimps achieve only 1/3rd of the weight gained by the females, an increase of production of some 50 per cent would theoretically be possible, if only females were stocked in the ponds instead of half females and half males as is usual. Stocking experiments in this respect are highly recommended. Experimental ponds of the Dagat-dagatan station should be stocked some with only males, some with only females and some with males and females in equal proportions. Although perhaps unlikely, it is possible that the presence of one sex influences the growth rate of the other. The expert also considered it desirable to check in aquaria experiments whether sex is already fixed at the larval stages or its determination could be influenced by certain environmental factors, such as salinity or temperature, as is known to happen in some fish species and other crustaceans. It is possible that the sex determination would be influenced in the fry so that a method could be developed to breed only females and thus considerably strengthen shrimp culture in the country.

In the opinion of the expert there is little possibility of increasing shrimp production on present fishing grounds by regulating the fishery through the introduction of a closed season,

since shrimps which have not been caught during the first year leave these grounds for deeper water.

RESEARCH PROGRAM

In the light of what has just been said the program described here is essentially a continuation of lines of study initiated within the terms of the general conclusions given in Section 5.2 this program should best serve the interests of Philippine fisheries in their present conditions.

Research on Pelagic Fish Stocks.

Since the expert considers that the resources of anchovies, roundscads, chubmackerels and other pelagic fish are exploited less than they could be, he considers it desirable that researches on these groups should be along lines that would furnish information from which the industry would be able to extend and increase its operations. For these purposes he would propose the following principal lines of study:

(*i*) Analysis and assessment of fluctuations in catch for which purpose detailed records should be kept of landings and of the fishing operations. Such records should show not only the amount of effort expended but the areas in which effort is expended by each vessel;

(ii) Hydrographic and biological study of the areas in which fishing principally takes place at present, maintaining these studies throughout the year and not confining them to the fishing season;

(iii) The extension of prospecting operations into adjacent areas in which it may be expected that stocks of these fish would be found.

The expert has the following special observations to make in connection with the sea-going research that should be carried out as part of these studies, and on the vessels that should be used for them. In the first place he would emphasize that the fullest possible use should be made of the opportunities for research provided by commercial fishing vessels. The information, concerning the stocks, which is to be drawn from the statistics of catch and operations should be extended by established research methods of analysis of the composition of catch. Whilst much of this can be done at landing places and in markets, it should be supplemented by similar work carried out on commercial vessels: appropriate environmental studies should be made in the course of such sea-going work on commercial

vessels. Again, the fullest use should be made of these commercial operations to complete the understanding of the distribution and characteristics of stocks within the range of operation of these vessels, and research vessels should work this area only for such operations as cannot be made effectively from commercial vessels. Among such operations will be the systematic collection of eggs, larvæ, and young fish not taken in the systematic collection of eggs, larvæ, and young fish not taken in the commercial catches, and the use of special hydrographic equipment that cannot be placed on commercial vessels. A research vessel should be available for the special planktonological and hydrographic studies, and also to carry out prospecting and exploratory fishing, beyond the present range of the commercial vessels.

Research is also necessary on the Clupeidæ (herrings and sardines) but in this case the initial studies should be concerned with identification of the species inhabiting these waters. There are apparently some 20 species, and correct identification should be effected before biological studies are initiated. It is possible that much can be accomplished in the first instance by a study of the specimens of these species occurring in the basnigan catches.

Rastrelliger is an important species in this area, on which detailed studies should be made. The expert considers that research on this group should be carried out along the lines formulated during the International Training Centre on the Methodology and Techniques of Research on Mackerel (Rastrelliger), held in Bangkok, Thailand from 20 October to 28 November 1958. He considers also that the recommendations made at that Centre for standardization of techniques should be implemented in the Philippines program.

Although the facilities available at the time of the expert's assignment did not permit of his making use of tuna as demonstration material in training fishery workers, he believes that the potential importance of this group to Philippine fisheries is such that the earliest opportunity should be taken to initiate a program of research on it. A tuna canning factory is being established at Navotas and initial studies could be made of the landings there. A research vessel will soon arrive from Japan to undertake work on this group and the fullest support should be given to its operations.

Research of Demersal Fish Stocks.

The intensity of the controversy with regard to exploitation of the demersal stocks in Manila Bay requires that these studies should have some priority within the research program. Considerable attention was paid to this matter during the expert's assignment, and the lines and methods on research that have been developed and which are described in Chapter IV should be continued. Particular attention should be paid to the analysis of the composition of catch taken by various gears, and these data should be supplemented by trawling from a research vessel. Such research fishing should be carried out in a way to complete the pattern of sampling of these stocks throughout their range of distribution. Such operations should be standardized with regard to the selection of stations, the frequency of operation at each station, the gears to be employed, and the duration and other characteristics of each unit operation. Detailed analysis of the catches taken by such operations should be made in the pattern established during the expert's assignment.

Observations made above, in Section 5.31 with regard to pelagic resources, on the use of commercial vessels and the complementing of their work by the work of research vessels, is applicable to these studies of demersal stocks.

Taxonomic Research.

The experience of the expert was that despite the very extensive taxonomic research carried out by previous ichthyologists there still remained a great deal of uncertainty with regard to the identity of many of the species occurring in the commercial catches in the Philippines. This is a problem not only of identification of species but of determination of sub-specific fragmentation, and the expert believes that special attention should be paid in the study of each group of commercially important species, not only to be identification of species, but to the possibility that populations of sub-specific status exist and maintain autonomy. It is his belief that settlement of this question has a considerable bearing on some of the controversial issues raised in the commercial fisheries. In certain cases the populations are autonomous and restricted to a degree to make them extremely vulnerable to intensive exploitation. In other cases he believes that this autonomy does not exist and that whilst fishing is confined to one part of the area of distribution of the stocks, there is replenishment from other parts of the

area, so that the risk of reduction of the stocks to unsuitable level is, as yet, not so great.

Hydrographic Research.

The expert has found that insufficient attention has been paid to the taking of hydrographic observations in conjunction with biological observations and sampling, so that the biologists have been unable to examine the connection between various features of the material being studied by them and the environmental factors that might be expected to play some part in determination of these features. He believes that an effective program of hydrographic research should be formulated, and suggests that assistance should be sought from UNESCO in planning and setting up such a program. For the present he recommends that a scheme of routine observations should be set up to be made aboard research vessels and commercial fishing boats. He also suggests that as soon as possible at least three shore stations should be established at which to take daily records of surface and bottom water temperature, salinity and tide level. He proposes the location of these stations on Corregidor, San Miguel Bay, and on the south coast of Mindanao.

Planktonological Research.

Very considerable and important advances in the fisheries research can be achieved by effective use of planktonological techniques. These refer primarily to the collection of eggs and larvæ and hence the identification of spawning places and times, and secondly to the accumulation of information on the food supplies of those organisms that feed on plankton. The expert therefore believes that the programs already established in this field should be continued and made still more systematic. He considers that for effective prosecution of such research there should be proper identification of the organisms occurring within the plankton community and suggests that help should be sought from specialists in other parts of the world in the identification of some of these organisms.

Benthos Research.

Work in this field is of a standing similar to that in the planktonological field. It is important with regard to reproduction and nutrition of the demersal species of commercial importance. Appropriate bottom sampling equipment should be obtained as soon as possible, and a program of systematic sam-

pling of the benthos community should be established.

Primary Production:

The evaluation of primary production in the various areas in which commercial species occur is an important approach to assessment of these stocks. Research in this field initiated in Manila Bay and San Miguel Bay should be continued. Extension of the work to other areas should be undertaken as soon as equipment and facilities become available, and in particular there is a problem of securing supplies of radioactive isotopes.

SUMMARY OF RECOMMENDATIONS

After a consideration of the foregoing conclusions, the expert is able to make the following recommendations:

General:

(1) That steps should be taken to establish a comprehensive overall view of the problems confronting Philippine fishery workers and of the program that should be prosecuted to solve these problems.

(2) That continuity should be maintained in the research work.

(3) That there should be further development of the fishery services of the Philippines, especially on the economic side.

Staff and Facilities:

(4) That steps must be taken to ensure that trained research staff should be retained in service and provided with the means of continuing their investigations.

(5) That the research staff should be assisted to continue to improve their qualifications.

(6) That arrangements should be made to attract and train other workers.

(7) That better rewards should be offered for employment in research.

(8) That the budget, given as Appendix 7.7 should be regarded as representing the minimum of needs for the Bureau.

(9) That the present Division of Fisheries Research should be treated as the nucleus around which to construct a fisheries research centre which, although connected with the Bureau of Fisheries for policy mat-

ters, should have an independent budget and separate administration.

(10) That a special building should be constructed for research in hydrography, plankton, benthos and primary production, and another for brackishwater research.

(11) That a lecture hall, more suitable storage for oceanographic equipment, a workshop and a dormitory for some of the workers and for guest research workers, should be provided.

(12) That a footbridge across the Malabon River should be provided.

(13) That the name of the research station should be changed from the Dagat-dagatan Saltwater Experimental Station to "The Dagat-dagatan Fisheries Research Station".

(14) That special consideration should be given to the needs of the station with respect to research vessels.

(15) That the station should establish a special publication series, in non-permanent (mimeographed) form, for quick dissemination of bulky raw data, such as station lists.

Research on Pelagic Fish Stocks:

(16) That researches on the stocks of anchovies, roundscads, chubmackerel and certain other pelagic species should be along lines that would furnish information from which the industry would be able to extend and increase its operations.

(17) That the fullest possible use should be made of the opportunities for research provided by commercial fishing vessels.

(18) That information drawn from the statistics of catch and operations should be extended by established research methods of analysis of the composition of catch.

(19) That appropriate environmental studies should be made in the course of sea-going work on commercial vessels.

(20) That a research vessel should be available for special planktonological and hydrographic studies, and also to carry out prospecting and exploratory fishing, beyond the present range of the commercial vessels.

(21) That there should be research on the Clupeidæ of which the initial studies should be concerned with identification of the species inhabiting these waters.

(22) That research on the *Rastrelliger* group should be carried out along the lines formulated during the International Training Centre on the Methodology and Techniques of Research on Mackerel (*Rastrelliger*) held in Bangkok, Thailand from 20 October to 28 November 1958.

(23) That the recommendations made at the Rastrelliger Centre for standardization of techniques should be implemented in the Philippine program.

(24) That the earliest opportunity should be taken to initiate a program of research on the tuna group.

(25) That the fullest support should be given to the operations of a tuna research vessel soon to arrive from Japan.

Research of demersal fish stocks:

(26) That particular attention should be paid to the analysis of the composition of catch taken by various gears.

(27) That the data obtained from the analysis of the composition of catch should be supplemented by trawling from a research vessel.

(28) That such operations should be standardized with regard to the selection of stations, the frequency of operation at each station, the gears to be employed, and the duration and other characteristics of each unit operation.

(29) That detailed analysis of the catches taken by such operations should be made in the pattern established during the expert's assignment.

Taxonomic Research:

(30) That special attention should be paid in the study of each group of commercially important species not only to the identification of species, but to the possibility that populations of subspecific status exist and maintain autonomy.

Hydrographic Research:

(31) That an effective program of hydrographic research should be formulated.

(32) That assistance should be sought from UNESCO in planning and setting up such a program.

(33) That for the present the scheme of routine observation already set up to be made on aboard research vessels and commercial fishing boats should be continued.

(34) That as soon as possible at least three shore stations should be established at which to take daily records of surface and bottom water temperature, salinity and tide level.

(35) That these shore stations should be located at Corregidor, San Miguel Bay and on the south coast of Mindanao.

Planktonological Research:

(36) That the programs already established for effective use of planktonological techniques should be continued and made still more systematic.

(37) That there should be proper identification of the organisms occurring within the plankton community.

(38) That help in the identification of some of these organisms should be sought from specialists in other parts of the world.

Benthos Research:

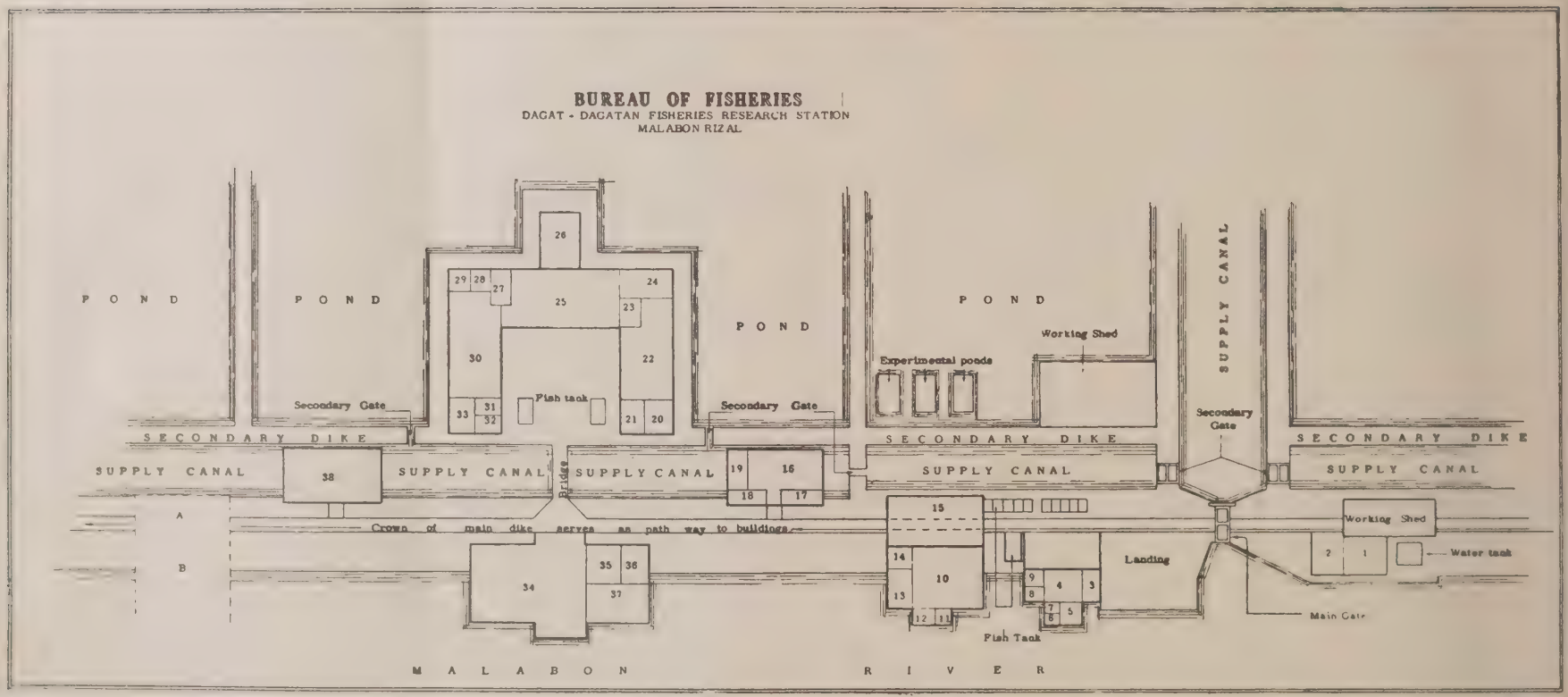
(39) That appropriate bottom sampling equipment should be obtained as soon as possible.

(40) That the program established for systematic sampling of the benthos community in Manila Bay and San Miguel Bay should be continued and be extended to other areas.

Primary Production:

(41) That research should be continued in evaluation of primary production which has already been initiated in Manila Bay and San Miguel Bay.

(42) That extension of this work to other areas should be undertaken as soon as equipment and facilities become available.


BUREAU OF FISHERIES
DAGAT - DAGATAN FISHERIES RESEARCH STATION
MALABON RIZAL
POND
POND
POND
POND
SUPPLY CANAL
Working Shed
Experimental ponds
Secondary Gate
Fish tank
Secondary Gate
Secondary Gate
SECONDARY DIKE
SECONDARY DIKE
SECONDARY DIKE
SUPPLY CANAL
SUPPLY CANAL
SUPPLY CANAL
SUPPLY CANAL
SUPPLY CANAL
Bridge
Crown of main dike serves as path way to buildings
Landing
Working Shed
Water tank
Main Gate
Fish Tank
MALABON
RIVER
G 1495

APPENDIX 7.0

Ground Plan of Dagat-dagatan Research Laboratories.

Legend:

A. *Existing Building and Laboratories*

1. Equipment Bodega
2. Guard house
3. Fish Culture Laboratory
4. Fish Culture Laboratory
5. Laborer's quarters
6. Laborer's quarters
7. Toilet and Bathroom
8. Guard's quarters
9. Guard's quarters
10. Library
11. Photographic Laboratory
12. Taxonomic Laboratory
13. Physiological Laboratory
14. Aquaria room
15. Administration
16. Pelagic fish Laboratory
17. Supply room
18. Supply room
19. Fish collection room
20. Office
21. Office
22. Demersal Fish Laboratory
23. Storeroom
24. Statistical Laboratory
25. Planktonological Laboratory
26. Temporary Bodega
27. Hydrographic Laboratory
28. Office
29. Office
30. Chemical Laboratory
31. Toilet
32. Toilet
33. Bathroom
34. Technological Laboratory and Pilot Canning Plant
35. Office
36. Office
37. Bacteriological Laboratory
38. Bodega

B. *Proposed Laboratories*

a. Brackish-water Laboratory
b. Oceanographic Laboratory

List of equipment as acquired through the joint effort of the Bureau of Fisheries, the National Research Council, the National Science Board, the National Economic Council, the Resident Representative of UNTAB, the FAO and the Colombo Plan through the United Kingdom.

A. *Hydrographic and Biological Field Equipment*

	Units
Hensen egg nets	4
Small plankton nets	2
Plankton bolting cloth	1
Standard zooplankton nets of Marutoku-B type	2
Ring trawls	4
Automatic closing device for plankton net	1
Petersen bottom samplers	2
Flow meter	1
Baby trawl nets	10
110V-electric generator, portable	1
Calibrated steam thermometer	1
Steam thermometers	5
Messenger for Nansen Bottles	12
Field binocular	2
Forester compass	1
Aneroid Barometer	1
Exacta-Varex camera with micrographic accessories	1
Rolleiflex camera	1
Light meter	1
Sieves	10
Banieras	10
Measuring boards	20
Spring balances	10
pH meter	1
Electric airpaint sprayer	1

B. *Hydrographic and Biological Laboratory Equipment*

Binocular microscopes of different kinds	14
Utermoehl-Plankton microscope	1
Compound microscope	1
Microscope lamps	6
Camera lucida	1
Magnifying glass	3
Plankton counting chambers	2
Micrometer microscope stage	2
Centrifuge	1
Projector with accessories	1
Stop watch	1
Alarm clock	1
Photographic enlarger	1
Print dryer	1
Balances of different kind	11

Chainomatic balance	1
Torsion balance	1
Slide rules	9
Calculating machines of different kinds	8
Dissecting sets	30
Dissecting pans	16
Freezer	1
Refrigerator	1
Air conditioner	2
Aquarium circulating pump	2
Aeration pump	1
Aquaria, large	5
Aquaria, small	30
Complete fat extraction apparatus Soxhlet	6
Duplicating machine w/accessories	1
Knudsen automatic burettes	3
Knudsen automatic pipettes	3
Oxygen burettes	2
Set of drawing instruments	1
Pantograph	1
Writing set for lettering	1
Incubator	1
Electric hot plate	1
Tally counter	3
Scientific books	36

List of equipment being expected from the United Kingdom under the Colombo Plan.

A. *Hydrographic and Biological Field Equipment*

	Units
Salinity bottles, 150 ml. with transport boxes	2,000
Oxygenium bottles, 100 ml. with transport boxes	100
Munro Ekman reversing bottles with accessories	10
Meter wheel with counter	2
Deep-Sea thermometer, reversing th., protected type	12
Deep-Sea thermometer, reversing th., unprotected type	6
Galvanized steel cable	3,000 m.
Bathythermograph of different range with accessories	3
Electric winch to operate bathythermograph	1
Visibility discs	4
Aneroid barometer	1
Binoculars	2
Mate sextants	2
Hensen egg nets and spare part bolting cloth (15x)	5
Marutoku-B type, Standard plankton nets	10
Flow meters	10
Ring trawls	5
Bottom egg nets by Mielck	3
Ekman-Berge dredges	2

Gundry small mesh herring trawls	2
Petersen bottom grabs	5

B. *Hydrographic and Biological Laboratory Equipment*

Spectrophotometer with accessories	1
Drawing table	1
Electric calculating machine	1
Facit hand calculating machine	1
Electric incubator	1
Deep freezers	2
Centrifuge with accessories	2
Microtome	1
Epidiascope projector	1
Vacuum pressure pump	1
Distilled water apparatus	1
Analytical balance	1
Standard seawater in glass tube (Copenhagen standard water)	100
Silver nitrate crystals	20 lbs.
Dessicators	3
Automatic Knudsen burettes	6
Automatic Knudsen pipettes	6
Oxygen titration	6
Volumetric precision pipettes, div.	24

List of research staff who have participated in the training programme.

1. *Permanent employees of the Bureau of Fisheries.*

Mr. I. A. Ronquillo, M.A. Biological Sciences, Stanford University, USA, since October 1956.

Mrs. P. C. Borja, BS Zoology, U.P., since October 1956.

Mr. M. N. Llorca, BS Chemistry, Adamson University, since October 1956.

Mr. D. Gracia, BS Education, MLQ, since October 1956, left Dec. 1957, reassigned to his former position.

Mr. B. Y. Datingaling, BS Zoology, U. P. since October 1956.

Mrs. G. G. Caringal, BS Pharmacy, UST, since October 1956.

Mr. H. Angeles, PIFT, Fish Culture, since October 1956.

Miss E. Fajardo, PIFT, Fish Culture, since October 1956.

Mrs. R. M. Legasto (formerly Miss Mangahas), PIFT, Fish Culture, since October 1956.

Mr. V. Encina, PIFT, Fish Capture, since October 1956.

Mr. A. de Jesus, PIFT, Fish Capture, since October 1956.

Mr. D. J. Leoncio, PIFT, Fish Capture, since October 1956, left August 1957 for financial reasons, since he obtained a better item in ACCFA.

Mrs. R. Napugan, BS Chemistry, Adamson University, since October 1956.

Mrs. E. Caldito, PIFT, Fish Preservation, since October 1956.

Mr. E. Villamater, PIFT, Fish Culture, since October 1956.

Mr. I. Ijiran, student, since October 1956.

Miss L. Mañalac, BS Zoology, U.P., since January 1957.
Miss E. Tan, BS Pharmacy, UST, since January 1957.
Miss V. Batangantang, PIFT, Fish Preservation, since January 1957.
Mrs. C. B. Faylona (formerly Miss Batangantang), PIFT, Fish Preservation, since January 1957.
Mr. J. Neri, PIFT, Fish Capture, since January 1957, left Dec. 1957, reassigned to his former position.
Mrs. E. B. Sagala (formerly Miss Bobadilla), BS Zoology UST, since February 1957.
Mr. G. Legasto, student, since February 1957, left Jan. 1957, reassigned to his former position.
Mr. A. Erasga, PIFT, Fish Capture, since January 1958.
Mr. H. Sabino, Fisherman, since July 1958.

2. *Personnel paid from the Project Development Funds of the TAB.*

Miss E. Royeca, BS Zoology, UST, since October 1956.
Miss S. Ramos, PIFT, Fish Culture, since October 1956.
Mr. A. Mines, BS Zoology, U.P., since November 1956.
Miss F. Arce, PIFT, Fish Culture, since December 1956.
Miss R. Necesito, PIFT, Fish Preservation, since December 1956.
Miss N. Fandialan, PIFT, Fish Preservation, since December 1956.
Miss A. Balalta, PIFT, Fish Preservation, BS Education, Biology major, MLQU, since January 1957.
Miss C. Masajo, PIFT, Fish Culture, since February 1957.
Mr. A. Tengco, PIFT, Fish Culture, since February 1957.
Mr. B. Castillo, PIFT, Fish Culture, since February 1957.
Miss E. Parayno, BS Zoology, UST, since March 1957, left August 1958, for financial reasons, since she obtained a better item in a private company.
Miss E. Simon, PIFT, Fish Culture, since March 1957.
Mrs. A. Damacion, BS Pharmacy, PWU, since March 1957.
Mr. A. Valdez, PIFT, Fish Capture, since March 1957.
Mr. S. Bravo, BS Zoology, U.P., since April 1957.
Mr. E. Bernabe, BS Zoology, U.P., since April 1957.
Miss P. Divino, BS Zoology, UP, since April 1957.
Mr. V. Alvarez, PIFT, Fish Capture, since June 1957.
Miss L. Castro, BS Zoology, UP, since June 1957.
Miss T. Mangosing, BS Zoology, UP, since July 1957, left May 1958 for Japan. A five-year's scholarship on Fisheries has been awarded to her by the Japanese Government.
Miss R. Calvelo, PIFT, Fish culture, since July 1957.
Mr. J. Ordoñez, BS Zoology, UP since August 1957.
Mr. N. Peña, PIFT, Fish Capture, since March 1958.
Mr. T. Tupas, PIFT, Fish Capture, since March 1958.
Mr. E. Rodriguez, PIFT, Fish Capture, since April 1958.
Mr. R. de la Paz, BS Zoology, UP, since May 1958.

3. *Emergency employees paid by the Bureau of Fisheries.*

Miss L. Ong, Commerce student, FEU, since February 1958.
Miss R. Villanueva, BS Education, Biology major, PWU, since February 1958.

Miss R. Cahilig, ETC, FEU, since February 1958.
Miss L. Lumberio, PIFT, Fish Culture, since April 1958.
Miss M. Manzano, Commerce student, UE, since June 1958.
Miss R. Figueroa, BS Commerce, PCC, since June 1958.
Mr. J. Ganaden, BS Commerce, UE, since June 1958.
Miss T. Pulido, BS Pharmacy, UST, since July 1958.

List of research staff as classified in the project.

I. *Scientific staff*

1. *Fishery Research Biologist or Oceanographer:*

Mr. I. A. Ronquillo
Mr. B. Y. Datingaling
Mr. M. N. Llorca
Mrs. P. C. Borja

2. *Fishery Research Assistant:*

Mr. A. Mines
Mr. E. Bernabe
Mr. S. Bravo
Mr. J. Ordoñez
Mr. R. de la Paz
Mrs. R. Napugan
Mrs. G. Cariñgal
Miss E. Tan
Miss L. Mañalac
Miss P. Divino
Miss L. Castro
Miss E. Royeca
Miss A. Balalta

II. *Technical staff*

1. *Fishery Technician:*

Mr. V. Alvarez
Mr. A. Erasga
Mr. V. Encina
(Mr. D. Leoncio)

2. *Assistant Fishery Technician:*

Mr. N. Peña
Mr. H. Angeles
Mr. E. Villamater
Mr. I. Ijiran
Mr. A. Tengco
Mr. B. Castillo
Mr. T. Tupas
Mr. E. Rodriguez
Mr. J. Ganaden
Mr. H. Sabino
Mr. A. de Jesus
Miss E. Simon
Miss R. Calvelo
Miss E. Fajardo
Mrs. R. Legasto
Mrs. E. Caldito
Mrs. C. Faylona
Miss V. Batangantang
Miss S. Ramos
Miss F. Arce
Miss R. Necesito
Miss N. Fandialan
Miss C. Masajo
Mrs. A. Damacion
Mrs. E. Sagala

3. *Laboratory Aides:*

Mr. A. Valdez
Miss R. Figueroa
Miss M. Manzano
Miss R. Cahilig
Miss R. Villanueva
Miss L. Ong
Miss L. Lumberio
Miss T. Pulido

List of trainees and assignment.

1. *Biological Investigations*

1.1 *Research on Pelagic Fish Stocks*

1.11 *Anchovy*

Mrs. Legasto ..... (Biology)
Miss Batangantang ..... "
Miss Simon ..... (Statistics)

1.12 *Roundscads*
Miss Royeca ..... (Biology)
Mrs. Damacion ..... "
Mr. Villamater ..... "
Mr. Ijiran ..... (Statistics)
Miss Figueroa ..... "
Mrs. Napugan (Fat analyses)
Mrs. Caldito ..... " "

1.13 *Chub Mackerel*
Miss Fajardo ..... (Biology)
Mr. Tengco ..... "
Miss Manzano ..... (Statistics)

Food Investigations in connection with 1.11–1.12:
Miss Castro ..... (Thesis for MS in Zoology)

1.2 *Research on Demersal Fish Stocks*

1.21 *Slipmouth*
Miss Arce ..... (Biology)
Miss Fandialan ..... "
Mrs. Sagala ..... "
Miss Ramos ..... (Statistics)
Miss Villanueva ..... "

1.22 *Threadfin Bream*
Miss Masajo ..... (Biology)
Miss Necesito ..... "
Mr. Datingaling ..... (Statistics)

1.23 *Lizard Fish*
Mr. Mines ..... (Biology, etc.) (Thesis for MS in Zoology)
Mr. Peña ..... (Biology)

1.24 *Shrimps*
Mr. Bravo ..... (Biology, etc.) (Thesis for MS in Zoology)

Food Investigations in connection with 1.21–1.22:
Miss Divino ..... (Thesis for MS in Zoology)

Fecundity Investigations in connection with 1.1–1.2:
Miss Pulido .....

1.25 *Experimental Fishing (Baby trawl operation)*
Mr. de Jesus ..... (Sampling)
Mr. Valdez ..... "
Mr. Castillo ..... "
Mr. Sabino ..... "
Mr. Ganaden ..... "
Miss Calvelo ..... (Catch analysis)
Mrs. Caringal ..... (Statistics)
Mr. Erasga ..... "

1.3 *Taxonomic Research*
Miss Mañalac ..... (Anchovies)
Miss Balalta ..... "
Mr. Angeles ..... (Roundscads)
Mrs. Faylona ..... (Chub Mackerel, Lizard Fish)
Miss Tan ..... (Statistics)
Miss Ong ..... "

2. *Oceanographic Investigations*
2.1 *Hydrography*
Mr. Llorca
Mr. Encina
Mr. Tupas
Mr. Rodriguez
2.2 Mr. Bernabe (Thesis for MS in Zoology)
Mr. de la Paz
Miss Cahilig
Miss Lumberio
2.3 *Benthos*
Mr. Ordoñez (Thesis for MS in Zoology)
2.4 *Primary Production*
Mr. Alvarez

The following workers were responsible for the performance of the sampling programme at sea and developed into excellent seagoing men:

Mr. Encina, Mr. Mines, Mr. Alvarez, Mr. Angeles, Mr. Valdez, Mr. de la Paz, Mr. Bravo, Mr. Ordoñez, Mr. Tupas, Mr. Rodriguez, Mr. Peña—in the commercial otter trawl operation aboard commercial fishing boats; Mr. de Jesus, Mr. Tengco, Mr. Castillo, Mr. Sabino, Mr. Ganaden—in the baby trawl operation aboard the research banca; these and Mr. Llorca, Mr. Datingaling and Mr. Bernabe aboard the "M/V David Starr Jordan."

REPORT OF MONTHLY PROGRESS OF THE PROJECT[1]

TABLE 1. *Biological Investigations*

A. RESEARCH ON PELAGIC FISH STOCKS

1. Anchovy (Stolephorus)

		Number of samples (Manila Bay)	Number of specimens determined and measured from these following	Number of specimens researched in detail[2]	Number of stomachs sampled for food investigations	Number of specimens researched on stomach contents
Position number		1	2	3	4	5
1956	November	8	2,000	1,100	----------	----------
	December	9	4,000	1,800	----------	----------
1957	January	13	5,800	2,300	----------	----------
	February	15	2,900	2,400	----------	----------
	March	31	9,900	5,200	----------	----------
	April	18	6,100	3,200	16	----------
	May	19	3,900	2,100	10	10
	June	24	8,100	4,360	----------	----------
	July	13	9,200	3,590	87	57
	August	8	6,200	2,180	29	19
	September	14	7,520	4,330	100	50
	October	22	14,070	7,610	230	156
	November	21	13,270	4,680	200	70
	December	22	8,710	4,540	200	20
1958	January	15	13,060	2,280	140	----------
	February	20	10,550	5,490	70	20
	March	16	10,990	1,940	90	90
	April	30	22,030	5,670	180	80
	May	18	14,480	3,890		60
	June	10	6,050	2,180	150	70
	July	19	10,640	4,150	120	70
	August	18	9,420	5,850	180	----------
	September	14	9,640	2,730	120	----------
Total		397	208,530	84,370	1,922	772

[1] Tuna researches are not included, because they have not been continued and were never really systematically performed due to lack of facilities. Taxonomic studies are also not included, because they are difficult to summarize in such a monthly survey. Inasmuch as the statistical work has also not entered this chart, it represents consequently only a part of the activities.

[2] Under "specimen studied in detail" is to be understood the determination of length, weight, sex, maturity stage, and very often also the determination of length and weight of gonads and the recording of number of parasites, if present. In the first months also scales and otoliths were collected.

A. RESEARCH ON PELAGIC FISH STOCKS (cont.)

1. Anchovy (Stolephorus)

Position number	Number of other sampling areas (such as Batangas, Lingayen Gulf, San Miguel Bay, Iloilo) from these following	Number of new sampling areas	Number of samples determined and measured (each about 1–2 kg.)	Number of specimens determined and measured from these following	Number of specimens researched in detail
	6	7	8	9	10
1956 November					
December					
1957 January					
February					
March					
April	1	1	1	600	30
May					
June	1	1	3	490	340
July	3	2	6	9,830	990
August	3		6	2,760	800
September	3		6	3,450	1,200
October	3		6	8,910	200
November	1		6	3,290	
December	2		5	7,410	200
1958 January	1		4	2,460	
February	5	3	14	6,490	1,280
March	5	2	15	5,570	2,080
April					
May	3	1	8	3,150	1,050
June					
July					
August	1		1	120	
September					
Total	32	10	81	54,530	8,170

A. RESEARCH ON PELAGIC FISH STOCKS (cont.)

2. Roundscad (Decapterus)

	Number of samples (Palawan waters and others)	Number of specimens determined and measured from these following	Number of specimens researched in detail	Number of fat analysis	Number of stomachs sampled for food investigations	Number of specimens researched on stomach contents
Position number	11	12	13	14	15	16
1956 November	1	360	300	10		
December	1	600	270			
1957 January	3	1,100	1,100	20		
February	3	2,200	1,260	16		
March	4	10,200	1,600	23		
April	4	4,700	2,700	32		
May	5	2,520	1,940	18	34	34
June	5	2,626	1,600	30	91	91
July	4	3,350	2,060	24	62	36
August	6	1,806	1,556	18	60	10
September	7	1,280	1,920	45	140	59
October	10	2,860	2,630	58	149	42
November	5	1,370	1,370	12	149	50
December	8	2,050	1,900	30	38	1
1958 January	11	2,826	2,810	42	270	15
February	27	5,080	2,550	30	174	20
March	39	7,720	2,450	30	40	
April	36	6,350	1,730	30	180	26
May	32	7,900	3,050	30	140	20
June	30	7,880	2,760	36	150	90
July	27	7,150	2,240	30	120	
August	30	6,890	2,720	30	310	
September	25	5,260	2,010	30	160	
Total	319	96,260	43,460	618	2,227	479

A. RESEARCH ON PELAGIC FISH STOCKS (cont.)

3. Chub Mackerel (Rastrelliger Sp.)

		Number of samples measured in the market	Number of specimens measured	Number of samples different localities preserved	Number of specimens preserved, determined measured	Number of specimens researched in detail	Preserved materials checked until following month	Number of stomachs sampled for food investigations	Number of specimens researched on stomach content
Position number		17	18	19	20	21	22	23	24
1956	November			2	150	150	XII		
	December								
1957	January			5	400	400	I		
	February			11	1,000	500	II		
	March			10	800	400	II		
	April			16	600			15	15
	May			7	470				
	June			8	460				
	July			13	400	160	II		
	August	4	620	7	360	480	II-III		
	September	5	1,180	11	460	690	IV-VI		
	October	5	1,070	8	690	1,770	VII-XI	10	10
	November	10	1,590	11	840	840	X-XI	10	10
	December	7	1,190	8	740	220	XI		
1958	January	18	3,530	19	1,390	480	XII		
	February	13	2,210	12	840	360	XII		
	March	13	2,580	10	1,010	320	I		
	April	8	1,030	7	380	540	I		
	May	8	950	10	530	620	II		
	June	4	370	8	400	480	II		
	July	6	330	6	260	360	III		
	August	7	760	10	650	260	III		
	September	6	520	7	350	290	IV		
Total		114	17,930	207	13,070	9,820		35	35

[1] Whereas in the researches on Anchovies, *Decapterus* and *Leiognathus* caught in fish corrals, fresh samples are mostly studied and therefore the data concerning the number of specimen measured and studied in detail, belong to the same month under reporting here and in most of the other species such is not the case. These 100 specimens were sampled in February. In the chart the work reported has been done in the month under report. Due to lack of personnel samples have been worked out sometimes several months later (compare my field reports).

B. RESEARCH ON DEMERSAL FISH STOCKS

1. Shamaki (Lengthamus)

Fishing station	(1)	(2)	(3)	(4)	(5)
1956 [illegible]	2	4	200	204	[illegible]
[illegible]			---	900	[illegible]
1957 [illegible]	12	7	1,400	1,600	[illegible]
[illegible]	12	6½	1,200	2,400	[illegible]
[illegible]	12	5	1,000	2,200	[illegible]
[illegible]	12	8½	1,600	2,000	[illegible]
[illegible]	12	7	1,200	2,500	[illegible]
[illegible]	12	6	1,000	2,300	[illegible]
[illegible]	12	6	1,000	2,300	[illegible]
[illegible]	12	8	1,400	2,800	[illegible]
[illegible]	12	6	1,000	2,900	[illegible]
[illegible]	12	8	1,400	2,800	[illegible]
[illegible]	12	8	1,400	2,800	[illegible]
[illegible]	12	8	1,400	2,800	[illegible]
[illegible]	12	11	1,900	2,900	[illegible]
1958 [illegible]	12	4	800	1,000	[illegible]
[illegible]	12	7	1,200	1,500	[illegible]
[illegible]	12	9	1,500	1,800	[illegible]
[illegible]	12	10	1,700	2,000	[illegible]
[illegible]	12	10	1,700	2,000	[illegible]
[illegible]	12	9	1,500	1,800	[illegible]
[illegible]	12	8	1,400	1,700	[illegible]
[illegible]	12	2	400	1,400	[illegible]
August	12	10	1,700	2,000	[illegible]
[illegible]	12	7	1,200	1,500	[illegible]
Total	76	175.0	[illegible]	[illegible]	

[illegible] was removed about 20 days sampling interval.
[illegible] of fish stocks found in Manzai Bay.
[illegible] also in research activities in San Miguel Bay.

B. RESEARCH ON DEMERSAL FISH STOCKS (cont.)

1. Slipmouth (Leiognathus)

	Number of stomachs sampled for food investiga-	Number of specimens researched on stomach content	Number of samples (fish corrals)	Number of specimens determined and measured	Number of specimens researched in detail
Position number	30	31	32	33	34
1956 November					
December					
1957 January			2	2,100	600
February			2	2,300	600
March			2	2,200	600
April	97	69	4	3,900	1,600
May	142	126	1	1,490	300
June	106	30	1	860	
July	127	47			
August	85	36			
September	386	166			
October	281	155	1	4,480	
November	136	106	2	6,430	
December	144	77	3	8,210	
1958 January	96	95	4	9,410	400
February	199	57	4	6,260	200
March	89	50	4	6,900	200
April	403	72	6	10,050	
May	252	50	4	8,840	600
June	49	59	1	1,970	
July	321	50			
August	140	30			
September	105				
Total	3,158	1,275	41	76,400	5,100

B. RESEARCH ON DEMERSAL FISH STOCKS (cont.)

2. Threadfin Bream (*Nemipterus Japonicus*)

	Number of samples determined and measured aboard	Number of specimens determined and aboard measured	Number of cans of preserved specimens	Number of specimens researched in detail	Preserved Material checked until following month	Number of stomachs sampled for food investigations	Number of specimens researched on stomach contents
Position number	35	36	37	38	39	40	41
1956 November	11	1,880	2				
December				200	XI		
1957 January			2	200	XI		
February	7	2,000	3				
March	5	1,500	1	400	I		
April	3	670	1	940	II—III	19	19
May	13	2,580	3	1,120	III–V	11	11
June	6	1,840	6	1,440	V–VI	20	20
July	14	2,860	5½	1,800	VI–VII	50	50
August	11	1,690	5	1,540	VII–VIII	9	9
September	8	1,450	4	1,200	IX	30	30
October	6	1,040	3	740	X	20	10
November	8	1,950	2½		X	20	20
December	16	3,740	6½	810	XII	10	10
1958 January	6	1,350	3	750	I	20	10
February	8	1,860	4	800	II	20	10
			1				
March	2	620	1	150	III	10	10
April	10	1,780	2	320	IV	9	0
May	10	2,160	3	280	V	10	10
June	8	2,380	2	90	VI	10	0
July	6	1,370	1	130	VII	30	10
August	11	4,860	3	490	VIII	20	
September	12	3,240	4	110	IX	10	
Total	181	42,820	68.5	13,510		328	229

B. RESEARCH ON DEMERSAL FISH STOCKS (cont.)

3. Lizard Fish (*Saurida* Sp.)

	Number of samples determined and measured aboard	Number of specimens determined and measured aboard	Number of cans of preserved specimens	Number of specimens researched in detail	Preserved material checked until following month	Number of specimens researched on stomach contents
Position number	42	43	44	45	46	47
1956 November	9	2,620	2	100	XI	100
December				250	XI	250
1957 January	8	1,260	2	200	XI–I	200
February	9	2,800	4½	400	I	400
March	7	1,900	2½	500	I–II	500
April	8	1,700	3	360	II–III	360
May	11	2,150	3	990	III	990
June	5	1,350	2	570	IV	570
July	15	3,240	4	780	IV–V	780
August	11	1,260	4½	390	V–VI	390
September	10	1,690	3½	410	VI–VII	410
[6]	6		3			
October	7	4,200	2½	380	VIII	380
November	9	2,810	4	710	IX	710
December	16	2,180	8	680	IX	680
1958 January	7	910	3	850	X	850
February	9	3,220	4	760	XI	760
[6]	4		4			
March	4	1,450	3	710	XII	710
April	13	1,970	4	1,510	IV	1,510
May	16	4,450	4	710	V	710
June	13	7,210	3	510	VI	510
[6]	13		5			
July	3	820	1	530	VI	530
August	8	2,180	3	270	VI	270
September	8	1,030	5			
Total	229	52,400	89.5	12,570		12,570

B. RESEARCH ON DEMERSAL FISH STOCKS (cont.)

4. Shrimps

	Number of samples determined and measured aboard	Number of specimens determined and measured aboard	Number of cans of preserved specimens	Number of specimens researched in detail	Preserved material checked until following month
Position number	48	49	50	51	52
1956 November	12	4,500	2		
December					
1957 January	14	2,300	1		
February	4	1,450	2		
March	2	660			
April	9	1,730			
May	13	2,430	3		
June	12	1,470	1		
July	18	3,290	3		
August	12	870	1½	1,210	VI
September	14	1,620	1	400	VII
"	10		2		
October	22	4,460	1	280	VIII
November	10	2,840	1	310	VIII
December	25	3,020	2	460	IX
1958 January	16	1,220	1	510	X
February	22	4,160	2	330	X
"	7		4		
March	6	1,860	1	500	XI
April	30	2,080	2	260	I
May	25	4,840	2	80	I
June	34	11,920	2	150	II
"	22		6		
July	10	1,860	1	70	III
August	26	7,260	2	90	IV
September	52	8,880	2	40	V
Total	427	74,720	45½	4,690	

I. Biological Investigation

		B. Research on Demersal Fish Stocks 5. Experimental fishing a. In the shallow coastal parts (2–10 m) (Baby trawl operation)				
	No. of field trips (each 8–10 hrs.)	No. of samples (net hauls) determined and measured in the laboratory	No. of specimens determined and measured	Preserved materials checked until following month b. In parts deeper than 15 m. Compare commercial otter trawl operation (B 1–4) and to this.	No. of samples of Gerres, Pentaprion, Apogon, Pomadasids and other specimens measured aboard	No. of specimens determined and measured aboard
Position number	53	54	55	56	57	58
1956 November						
December						
1957 January						
February						
March						
April	5	20	8,400	IV		
May	3	11	6,200	IV–V	3	680
June	3	12	3,500	V–VI	4	1,360
July	5	9	7,260	VI–VII	5	2,530
August	5	31	32,600	VII–VIII	16	2,380
September	6	12	10,990	IX	15	3,020
6					10	
October	8	45	39,430	X	9	3,960
November	7	22	22,730	X–XI	14	2,770
December	6	20	70,010	XI	6	1,750
1958 January	6	44	98,570	XII	14	1,450
February	8	52	14,300	II	10	1,990
6					3	
March	10	70	28,290	III	3	1,020
April	12	104	25,930	IV	30	4,410
May	11	73	37,900	V	14	3,920
June	10	10	10,680	VI	13	5,350
6					14	
July	12	55	42,370	VII	3	500
August	13	16	56,830	VII	10	3,390
September	10	46	63,370	VIII	18	5,190
Total	140	652	579,910		214	45,670

II. Oceanographic Investigation

	No. of stations (hauling of nets or fixed stations (I–4) [b]	B. Research on Demersal Fish Stocks 1. Hydrography (Manila Bay and San Miguel Bay) in connection with I and II–4					
		No. of temper. data (surface and bottom)	No. of salinity data (surface and bottom)	Following date only in connection with II–2 to 4 in Manila Bay	No. of oxygen nium data No. of pH data	No. of transparency data (Secchi disk)	No. of phosphate data
Position number	59	60	61	62	63	64	65
1956 November	30	60	60				
December							
1957 January	28	56					
February	29	58	58				
March	15	30	30				
April	47	94	94			3	
May	35	70	70	12	10	5	
June	37	74	74	12	11	5	13
July	47	94	94	15		5	14
August	102	184	184	108	42	60	108
September [c]	59	75	99	19	13	7	19
October	85	110	142	12		6	13
November	60	66	94	14		5	14
December	72	131	131	23		9	23
1958 January	55	96	96	22		9	22
February	60	101	101	23		8	23
[c]	21	42	42				
March	63	93	93	41		9	41
April	72	113	113	23		9	23
May	69	112	112	23		9	23
June	63	96	96	14		7	14
[c]	24	48	48				
July	50	64	64	6		3	6
August	71	106	106	13		5	13
September	64	112	112	32		9	32
Total	1,258	2,085	2,169	412	76	173	401

II. Oceanographic Investigation

	B. Research on Demersal Fish Stocks 2 Plankton				
	No. of field trips (Manila Bay)	Stations visited [5]	No. of vertical catches (Hensen egg net)	No. of vertical catches (small net, each 3 hauls)	No. of horzontal catches
Position number	66	67	68	69	70
1956 November					
December					
1957 January					
February					
March					
April	1	ABCD	12		5
May	1	ABCDE	18		5
June	1	ABCDE	15		5
July	1	ABCDE	15	2	5
August	2	A–ABCD	15	3	7
September	1	ABCDE	15	2	5
October	1	ABCDE	15	2	5
November	1	ABCDE	15	2	5
December	1	ABCDE	13	2	5
1958 January	1	ABCDE	15	2	5
February	1	ABCDE	13	2	5
March	1	ABCDE	15	2	5
April	1	ABCDE	15	2	5
May	1	ABCDE	15	2	5
June	1	ABCD	12	2	4
July	1	ABC	9	1	4
August	1	ABCDE	15	2	5
September	1	A–E–4	32	2	5
Total	19	90	274	30	90

II. Oceanographic Investigation

	B. Research on Demersal Fish Stocks 2. Plankton				
	No. of samples roughly sorted	No. of other sampling areas (such as Batangas Bay and San Miguel Bay) from these following	No. of new sampling areas	No. of stations and catches (vertically with small net, each catch represents 3 hauls)	No. of samples sorted
Position number	71	72	73	74	75
1956 November					
December					
1957 January					
February					
March					
April					
May	17				
June					
July	43	2	2	5	
August	22	1		1	5
September	9	1		2	
October	16	2		17	
November	11	2	1	5	
December	6	2	1	6	
1958 January	12	1		2	
February	4	2		15	
March	5	2	1	3	
April	8				
May	49				
June	20	1		9	
July	9				
August	20				
September	17				
Total	268	16	5	65	5

II. Oceanographic Investigation

	B. Research on Demersal Fish Stocks					
		3. Benthos (Manila Bay and San Miguel Bay)			4. Primary Production (Manila Bay and San Miguel Bay)	
	No. of field trips	Stations visited [5]	No. of samples	No. of samples sorted	Stations visited	No. of samples (including control samples)
Position number	76	77	78	79	80	81
1956 November						
December						
1957 January						
February						
March						
April						
May						
June						
July						
August	4	60	60			
September	1	15	33	11		
[6]	1	17	17			
October	1	9	27			
November	1	9	27	1		
December	1	9	27	10		
1958 January	1	9	27	144		
February	1	9	27	89		
[6]	1	21	21		21	63
March	1	22	34	12	22	66
April	1	9	23	56		
May	1	9	27	27	4	12
June	1	7	21	30		
[6]	1	24	30		4	36
July				21	4	36
August					5	45
September					5	45
Total	17	229	401	401	65	303

Budget proposal for the section of hydrology and fisheries biology for the fiscal year 1959–1960.

I. *Personal Services*

1. 15 Asst. Fishery Technicians (Marine Biology) at ₱2,672 per annum	₱40,140.00	
2. 10 Fishery Aides (Marine Biology) ₱1,440 per annum	14,400.00	
3. For hire of emergency laborers at ₱4.80 per day	18,000.00	
Total		₱72,540.00

II. *Maintenance and Other Operating Expenses*

1. Traveling Expenses	₱15,000.00	
2. Supplies and Materials	15,000.00	
3. Sundry	6,000.00	
4. Boat Maintenance and Operation	6,000.00	
Total		₱42,000.00

III. *Furniture and Equipment*

(Please see list hereto attached)		₱6,480.00

IV. *Capital Outlay*

1. Construction of oceanographic and plankton laboratory to house the equipment to come from Colombo Plan and specimens collected from Manila Bay	₱10,000.00	
2. Completion of a permanent foot bridge from the Dagat-dagatan Fishery Experimental Station to Loñgos, Malabon, Rizal	5,000.00	
3. Construction of a boat shed, net loft, storeroom at the Dagat-dagatan Salt-water Fishery Experimental Station	6,000.00	
4. Construction of a pier, garage and warehouse at the landing base at Loñgos, Malabon, Rizal	5,000.00	
Total		₱26,000.00
GRAND TOTAL		₱147,020.00

LIST OF EQUIPMENT URGENTLY NEEDED BY THE SECTION OF HYDROLOGY AND FISHERIES BIOLOGY

1.	2 Calculating machines, hand-operated at ₱350.00	₱700.00
2.	1 Typewriter, standard, Underwood, 11" carriage	400.00
3.	3 Electric fans, 12" blade at ₱130.00	390.00
4.	1 Distilling apparatus, electrically operated, 220 volts	700.00
5.	3 Slide rules at ₱100.00	300.00
6.	2 Steel cabinets at ₱180.00	360.00
7.	15 Ordinary office tables at ₱30.00	450.00
8.	3 Steel filing cabinets at ₱180.00	540.00
9.	60 Chairs for library at ₱9.00	540.00
10.	2 Microscopes, compound at ₱1,000.00	2,000.00
11.	1 set Drawing instruments	100.00
	Total	₱6,480.00

Outline for the preparation of synopses of data on species and stocks:

1. IDENTITY

1.1 *Taxonomy*
Definition
Description

1.2 *Nomenclature*
Valid scientific name
Synonyms
Standard common names, vernacular names

1.3 *General variability*
Subspecific fragmentation (races, varieties, hybrids)
Genetic data (chromosome number, protein specificity)

2. DISTRIBUTION

2.1 *Delimitation of the total area of distribution and ecological characterization of this area*

2.2 *Differential distribution*
Areas occupied by eggs, larvae and other junior stages: annual variations in these patterns, and seasonal variations for stages persisting over two or more seasons.
Areas occupied by adult stages: seasonal and annual variations of these.

2.3 *Behavioristic and ecological determinants of the general limits of distribution and of the variations of these limits and differential distribution.*

3. BIONOMICS AND LIFE HISTORY

3.1 *Reproduction*
Sexuality (hermaphroditism, heterosexuality, intersexuality)
Maturity (age and size)

Mating (monogamous, poligamous, promiscuous)
Fertilization (internal, external)
Fecundity
Relation of gonad size and egg number to body size and to age
Coefficient of fecundity
Spawning
Spawning seasons (beginning, end, peak)
Number of spawning per year, frequency
Spawning time of day
Induction of spawning, artificial fertilization
Spawning grounds
Coastal (surface, vegetation, shore, shoal, sand, shelter); bottom
Oceanic (surface, bottom)
Egg: structure, size, hatching type, parasites and predators

3.2 *Larval history*

Account of embryonic and juvenile life (prelarva, larva, post larva, juvenile)
Feeding
Rates of: development and survival
Periods of: development and survival
Parental care
Parasites and predators

3.3 *Adult history*

Longevity
Hardiness
Competitors
Predators
Parasites and diseases

3.4 *Nutrition and growth*

Feeding (time, place, manner, season)
Food (type, volume)
Relative and absolute growth patterns and rates
Relation of growth to feeding, to other activities, and to environmental factors

3.5 *Behaviour*

Migration and local movements
Schooling
Reproductive habits

4. POPULATION (STOCK)

4.1 *Structure*

Sex ratio
Age composition
Size composition

4.2 *Size and density*

Average size
Changes in size

Average density
Changes in density

4.3 *Natality and Recruitment*
Natality
Natality rates

4.4 *Mortality, morbidity*
Rates of mortality
Factors or conditions affecting mortality
Factors or conditions affecting morbidity
Relation of morbidity to mortality rates

4.5 *Dynamics of population*

4.6 *Relation of population to community and ecosystem biological production etc.*

5. EXPLOITATION *

5.1 *Fishing equipment*
Fishing gear
Fishing boats

5.2 *Fishing areas*
General geographic distribution
Geographical ranges (latitudes, distances from coast, etc.)
Depth ranges

5.3 *Fishing seasons*
General pattern of fishing season
Duration of fishing season
Dates of beginning, peak and end of season
Variation in time or duration of fishing season
Factors affecting fishing season

5.4 *Fishing operations and results*
Effort and intensity
Selectivity
Catches

5.5 *Fisheries management and regulations*

5.6 *Fish farming, transplanting and other intervention*

* Only information of relevance for the understanding of the biology of the species and effect of exploitation on the stocks should be considered.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Station map of Manila Bay.
2. Station map of San Miguel Bay.
3. Station map of proposed extended plankton survey.

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